Link 22 Guidebook

Overview

July 2013

Distribution: Statement A: Approved for public release; distribution is unlimited (25 November 2009)

NORTHROP GRUMMAN

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Guidebook
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July 2013

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Space and Naval Warfare Systems Command
4301 Pacific Highway
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Dedication

Preface

History and Background

During the late 1980s, the North Atlantic Treaty Organization (NATO), agreeing on the need to improve the performance of Link 11, produced a mission need statement that became the basis for the establishment of the NATO Improved Link Eleven (NILE) Program. The program specified a new tactical message standard in the NATO STANdardization AGreement [STANAG 5522] to enhance data exchange and provide a new layered communications architecture. This new data link was designated Link 22.

Requirements

The operational requirements are defined in the NATO Staff Requirement of the 9th of March 1990. The system, functional and performance requirements are defined in the NATO Elementary Requirements Document of the 12th of December 1994.

Goals

The Link 22 goals are to replace Link 11, thereby removing the inherent limitations of Link 11; to improve Allied interoperability; to complement Link 16; and to enhance the commanders' war fighting capability.

Memorandum Of Understanding

The Link 22 Program was initially conducted collaboratively by seven nations under the aegis of a Memorandum Of Understanding (MOU). The original seven nations were Canada, France, Germany, Italy, the Netherlands, the United Kingdom (UK), and the United States (US), with the US acting as the host nation. Spain has replaced the Netherlands as a NILE Nation.

The NILE Project began in 1987 and was originally governed by MOUs that successfully covered the Project Definition Phase and the Design and Development Phases. Since 2002, the Project has been governed by an MOU and its amendments that cover the In-Service Support phase.

A steering committee guides the complete program. The program is managed by the Project Management Office (PMO), located at the Space and Naval Warfare Command (SPAWAR)'s Program Management Warfare (PMW) 150 in San Diego, California.

The PMO consists of a representative from each participating nation and a Project Manager from the US.

Development Approach

The design of Link 22 was performed using a “layered” approach, similar to the layers of a standard ISO communications stack, which isolates specific functions within specific layers.

The layered development approach attempted to maximize the following.

- Reuse of existing Link 11 radios and equipment
- Use of Commercial Off-The-Shelf (COTS) computers
- Automated operation, thereby minimizing human-machine interaction

In addition, the goal of the message standard for Link 22 was to use as much of the Link 16 message standard, as possible.

Phased Development

Link 22 employed a phased development, as shown below.

- 1989 – 1992: Project Definition Phase
- 1992 – 1996: Design and Development Phase One
    - Develop the prototype Link Level COMSEC (LLC)
- 1996 – 2002: Design and Development Phase Two
    - Develop the production LLC
    - Develop the System Network Controller (SNC) software
    - Develop the High-Frequency (HF) fixed frequency Signal Processing Controller (SPC)
    - Develop the NILE Reference System (NRS) (Compatibility Tester)
    - Integrate Link 22 into the Multiple Link System Test and Training Tool (MLST3) (Interoperability Tester)
- 2002 – 2013: In-Service Support (ISS) Phase

SNC Standardization

To ensure compatibility across implementations, all participants must use the standard SNC software. Each implementing nation will acquire this software and will implement it in a hardware environment suitable for its own application.

Test Tools and Testbeds

The test tools consist of a compatibility tester called the NILE Reference System (NRS) and an interoperability tester, the Multiple Link System Test and Training Tool (MLST3). These test tools are complete systems, consisting of both hardware and software. The NRS can be used to test whether a nation's implementation of the SNC is compatible with the standard SNC. The MLST3 tests the interoperability of the new systems in a multilink environment, in which Link 22 may operate concurrently with Link 11 and Link 16.

Purpose

The intent of this version of the Link 22 Guidebook is to provide a reference document on the Link 22 System that is releasable to any Nation or National contractors that are interested in learning about Link 22. It is used to provide general information about the functioning and operation of the Link 22 system, including a description of the NILE products.

Structure

This guidebook is composed of the following three principal chapters.

- Chapter 1, containing executive-level information, for managers, and procurers
- Chapter 2, containing user-level information, for planners, operators, and technicians
- Chapter 3, containing technical-level information, for implementers, integrators, testers, and software engineers

Additionally Appendices for Integration and Test Tools, Troubleshooting, Minimum Implementation, Abbreviations and Acronyms, a Glossary, and a List of References may be found at the back of the guidebook.

How to use this book

This guidebook has been written in a manner that provides suitable information for Link 22 operators, planners, managers, executives, developers, and testers. Users can skip sections that are not of interest or applicable to them.

Chapter 1 should be read by managers, procurers, and anyone who is new to Link 22.

Chapter 2 should be read by planners, operators, and technicians (those in charge of hardware configurations).

Chapter 3 should be read by implementers, integrators, testers and software engineers.

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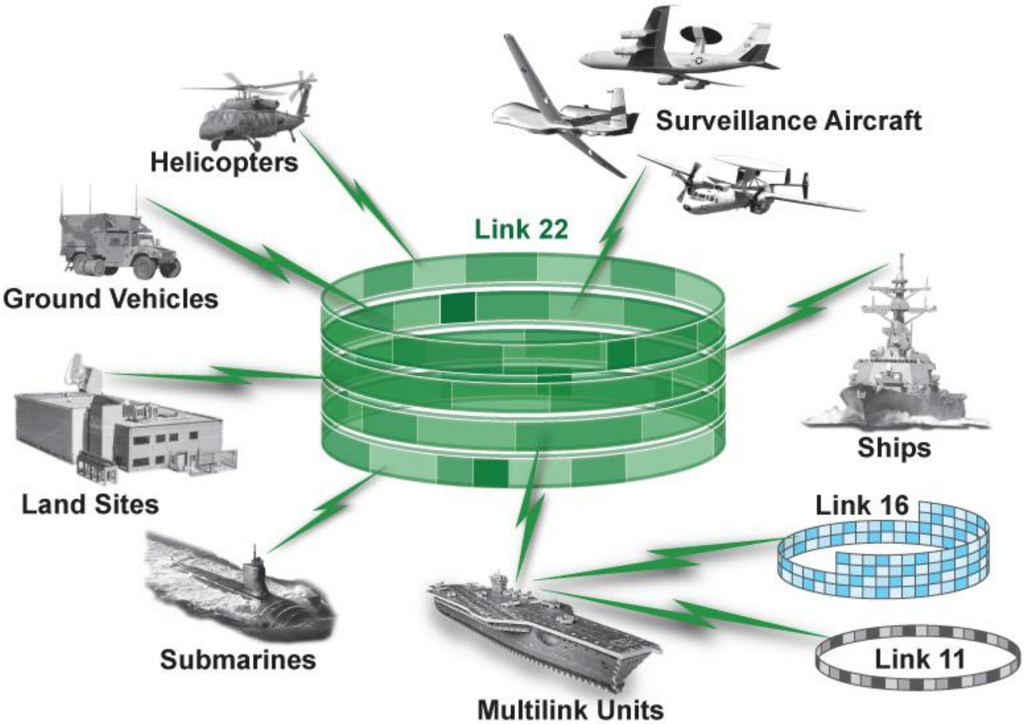
Chapter 1

Link 22 Overview

Section A Introduction



Link 22 is a North Atlantic Treaty Organization (NATO) secure radio system that provides Beyond Line-Of-Sight (BLOS) communications. It interconnects air, surface, subsurface, and ground-based tactical data systems, and it is used for the exchange of tactical data among the military units of the participating nations. Link 22 will be deployed in peacetime, crisis, and war to support NATO and Allied warfare taskings.

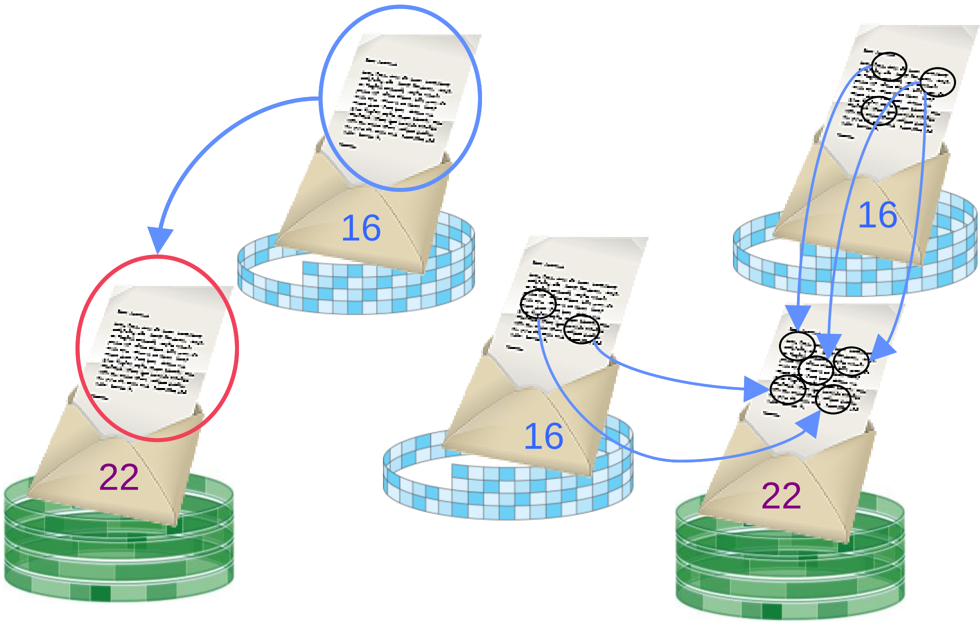
The Link 22 Program was initially conducted collaboratively by seven nations under the aegis of a **Memorandum Of Understanding (MOU)**. The original seven nations were Canada, France, Germany, Italy, the Netherlands, the United Kingdom (UK), and the United States (US), with the US acting as the host nation. Spain has replaced the Netherlands as a NILE Nation.

Link 22 was developed to replace and overcome the known deficiencies of Link 11. Link 22 was also designed to complement and interoperate easily with Link 16. It was designed with automated and simple management to ensure that it is easier to manage than both Link 11 and Link 16. This program is called **"NATO Improved Link Eleven"**, which is abbreviated to "**NILE**". The tactical data link provided by the NILE system has been officially designated Link 22.

Communications Security

Link 22 employs a strong COMmunications SECurity (COMSEC) system, which is provided by the inclusion of an integral encryption/decryption device inside the Link 22 system. This cryptographic device (crypto) at the data link level is called the **Link Level COMSEC (LLC)**. It uses the same electronic chip used by Link 16. The LLC also provides detection of attempts to disrupt the network. A new Modernized LLC (MLLC) is planned for the future, to comply with the US National Security Agency (NSA) Crypto Modernization Roadmap. Link 22 transmission security is also available by the optional use of frequency hopping radios.

Tactical Messages



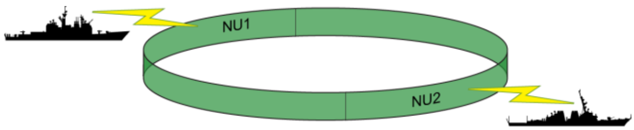
A Link 22 message can contain a complete Link 16 message

OR

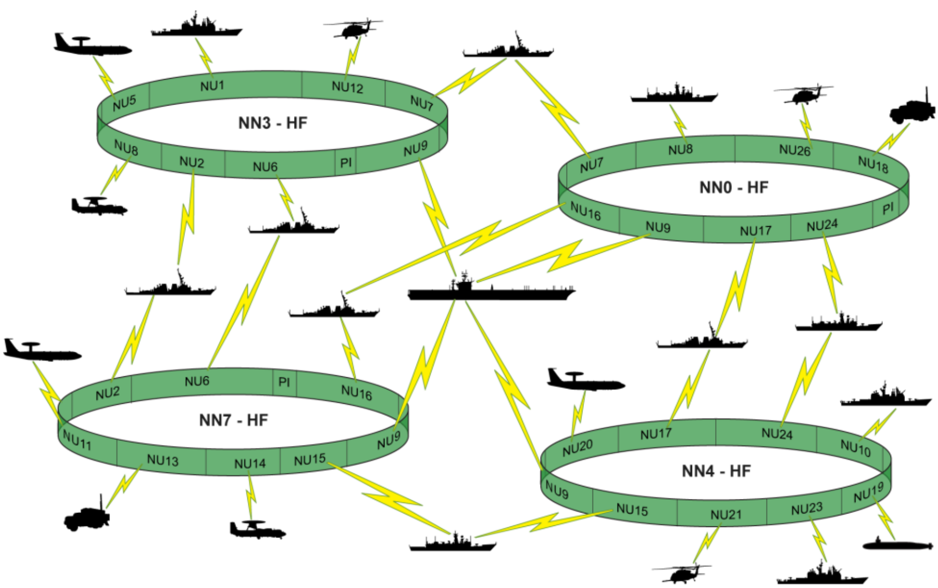
A Link 22 message can contain parts of Link 16 messages

Tactical data is transmitted on Link 22 in fixed format messages, which are part of the **J-Series** family of messages. It uses the same field definitions as Link 16 to provide standardization between the two tactical data links. Many of the Link 16 tactical messages are transmitted without modification within Link 22 tactical messages. Link 22 specific messages are more efficient versions of Link 16 messages and therefore use less bandwidth. Link 22 provides a number of **Quality of Service (QoS)** features, which are specified with each transmission request. Among other features, the selection of messages for transmission is based on the priority and the QoS of each message, which provides better use of available resources based on the operational situation.

Link 22 Super Network

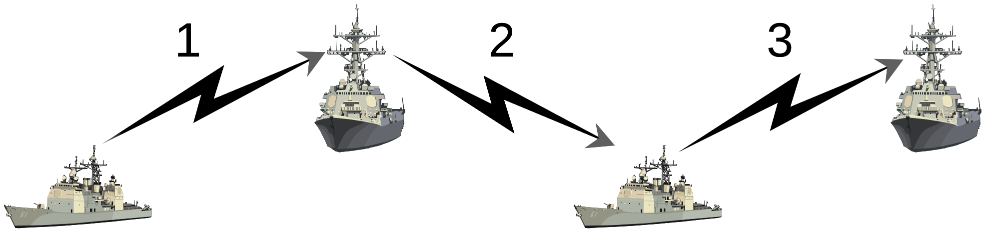


An operational Link 22 system is called a Link 22 **Super Network**. In its simplest form, a Link 22 Super Network consists of just two units communicating with each other in a single NILE Network. The most complex Link 22 Super Network would consist of the maximum number of units (125) with eight NILE Networks. A unit participating within the Link 22 Super Network can be a member of up to four of the NILE Networks. A more complex Super Network is shown below.



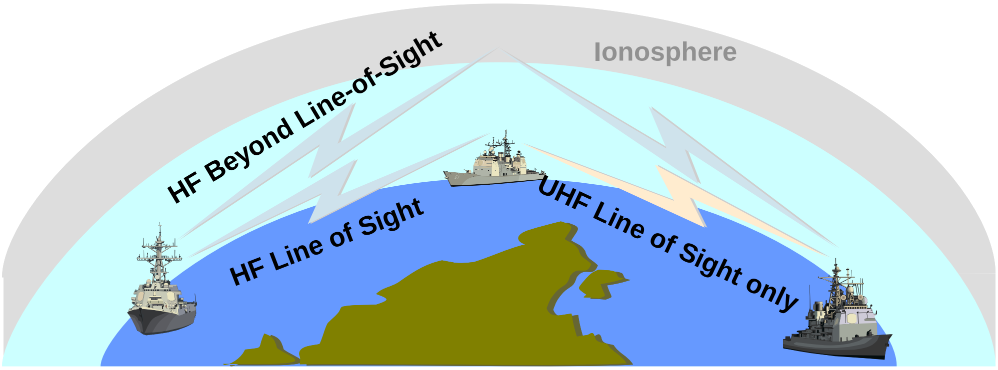
A Super Network enables seamless communication between units using different media to satisfy operational requirements within prevailing media propagation conditions. In a Super Network, any NILE unit can communicate with all other NILE units without regard to the NILE Network in which they are participating, thereby extending the operational theater. When a unit retransmits a message to extend coverage this is called relay, which is an automatic function of Link 22.

Automatic Relay



Coverage beyond what the media itself is capable of is provided by the automatic relay of messages and the ability to adapt to changes automatically, without operator intervention. This removes the need for dedicated air relay platforms and relay slot planning and management. A unit will automatically retransmit a received message when necessary to ensure that the message is received by its addressees. The System Network Controller (**SNC**) calculates whether the relay is necessary, based on its knowledge of the connectivity among units. The ability of a unit to relay can be affected by its relay setting. This setting's default is automatic relay, but the unit can be disabled from performing relay or designated as a preferred relayer. Relay is performed on a per message basis. Because messages are retransmitted only when necessary, this reduces the use of bandwidth.

Beyond Line-Of-Sight Communication



Each NILE Network can employ either High Frequency (HF) or Ultra High Frequency (UHF) communications.

HF communications are in the 2-30 MHz band, which provides Beyond Line-Of-Sight (BLOS) communication (HF Sky Wave or HF Ground Wave) optimized for (but not limited to) transmission up to 300 nautical miles. HF also provides direct Line-Of-Sight (LOS) communications.

UHF communications are in the 225-400 MHz band, which provides only LOS communication.

Within each band, either fixed frequency or frequency hopping radios can be used. Greater coverage is provided by the automatic relay of messages within the Link 22 system as previously mentioned.

Strong Waveforms and Error Correction

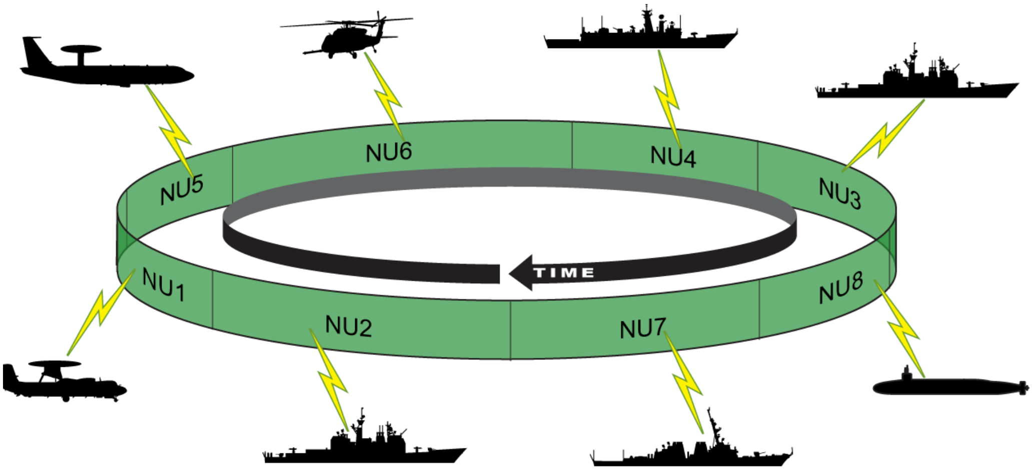
Link 22 has better tactical data throughput than Link 11, and it can even work in conditions where Link 11 will not. When conditions are bad, Link 22 can use more robust media parameters and maintain communication, although at a lower data rate than usual. When conditions are good, Link 22 can optimize the media parameters to maximize its data throughput. For example, specific media parameters were designed to operate in high latitudes, which present some of the worst-case conditions, and where Link 11 rarely operates.

Distributed Protocols – No Single Point of Failure

Link 22 uses distributed protocols, so it has no single point of failure (that is, the loss of a single unit does not cause the loss of an entire network). Some units perform specific management roles, but the system will continue operating without them. Each unit that performs a special role is required to designate a Standby unit, which can automatically take over the role in case of failure.

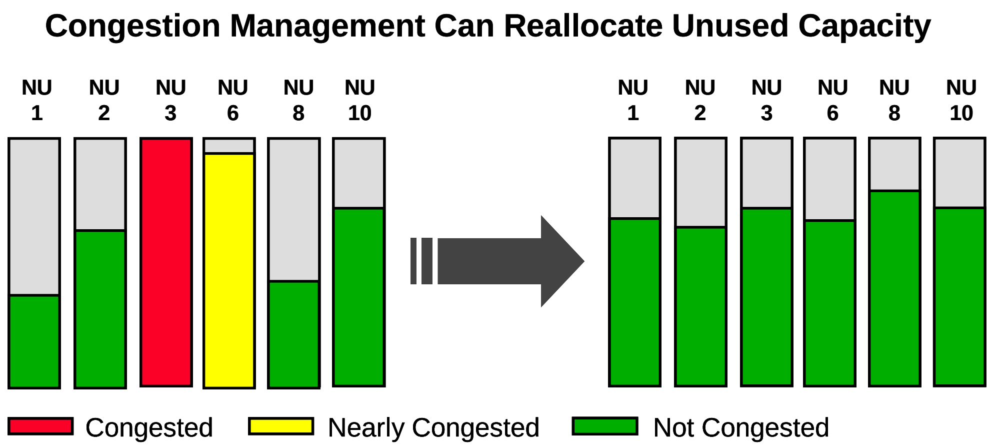
Link 22 has automated Network Management functions that require a minimum of operator interaction, if any. These functions are controlled by the transmission of Network Management messages. Each unit can define whether or not to automatically respond to, and whether or not to automatically perform, each of the Network Management functions.

Time Division Multiple Access



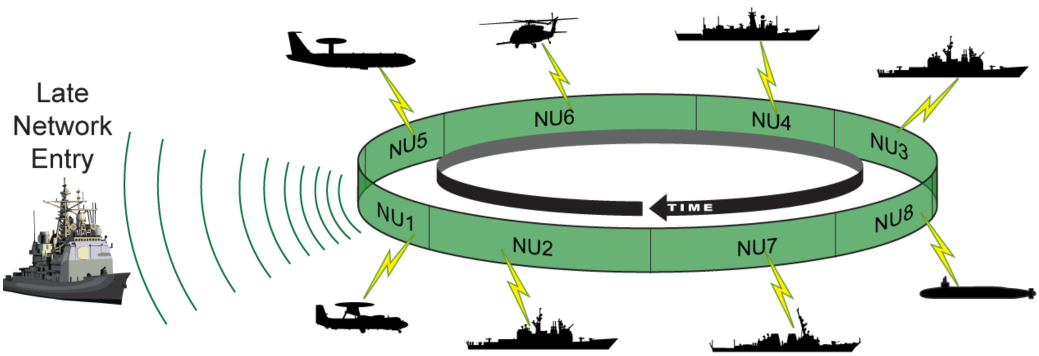
Time Division Multiple Access (TDMA) is the method by which the transmission capacity available to the entire network is distributed among its members. A cyclical period of time is divided up into timeslots, which can be of different durations. Most timeslots are allocated to specific units in the network. A unit transmits during its own timeslots. All other units listen during this period, and they may or may not receive the transmission. Priority Injection timeslots may be available, which can reduce the length of time a unit has to wait before it is able to transmit high-priority messages. If multiple units transmit in a Priority Injection timeslot at the same time, the transmission may not be received. Because of this, the transmission is also repeated in the units' own timeslot.

Automated Congestion Management



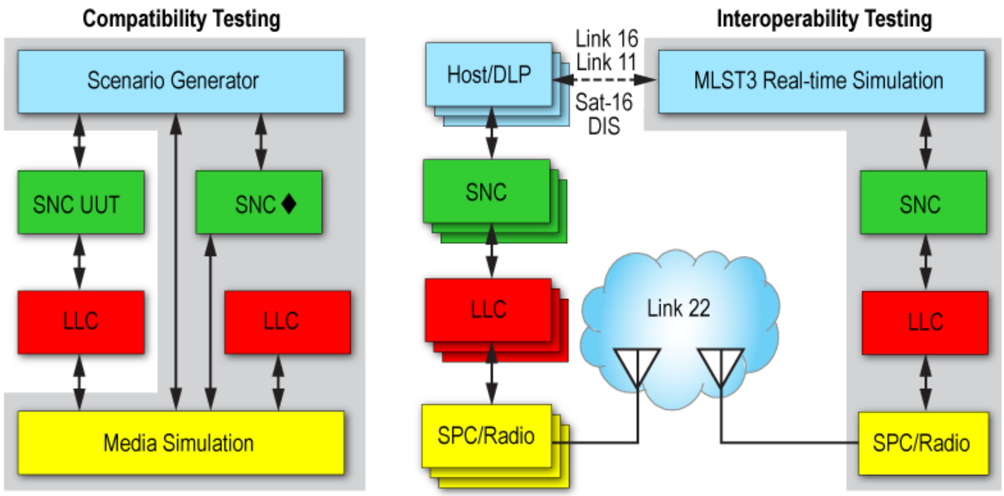
At the tactical level, when a unit is congested, it can reduce the local traffic that it generates based on the provided congestion information. In addition, Link 22 automates Congestion Management in a number of different ways. The routing of messages takes congestion into account and will route messages using alternative paths to reduce congestion. Link 22 has a Dynamic TDMA (DTDMA) protocol which, when enabled on a NILE Network, allow congested units to automatically request and receive additional capacity on a permanent or temporary basis (thereby modifying the TDMA structure). If DTDMA does not achieve the desired result, the unit managing a NILE Network can change the configuration of the network to redistribute the available capacity, or change the parameters of the media in use in an attempt to increase the network’s capacity. As a last resort, a unit can interact with the operator to decide which, if any, of the tactical messages received and queued for relay may be deleted.

Late Network Entry



After the Super Network has been started, units that arrive late can join the tactical data link by initiating a protocol called **Late Network Entry (LNE)**. The system also supports units that just want to listen to a network, called receive-only units, which have the capability to request access to the network, but are not allocated any transmission capacity. In addition, the system also supports units that only want to listen to a network without performing any transmissions at all (silent join units).

Test Facilities



The NILE Project has funded the development of extensive Link 22 test facilities that are available for both compatibility and interoperability testing. Only these test systems are covered by this guidebook. Nations may develop their own Link 22 test systems, but they are not included in this guidebook.

The compatibility test system is called the NILE Reference System (NRS), which was developed to test the System Network Controller (SNC) and ensure that all modifications to the SNC meet and continue to meet the Link 22 requirements. It can also be used to test the other components of the Link 22 system, such as the LLC and SPCs/Radios.

The interoperability test system is called the Multiple Link System Test & Training Tool (MLST3). This was an existing system which was extended to incorporate the Link 22 DLP simulation/functionality providing a tactical interface as defined in STANAG 5522. This also required the implementation of the DLP-SNC interface. MLST3 has multiple configurations available for testing; most test configurations require the approved use of SNC and NRS components, the distribution of which is managed by the NILE PMO.

Test Tool details are in Appendix A.

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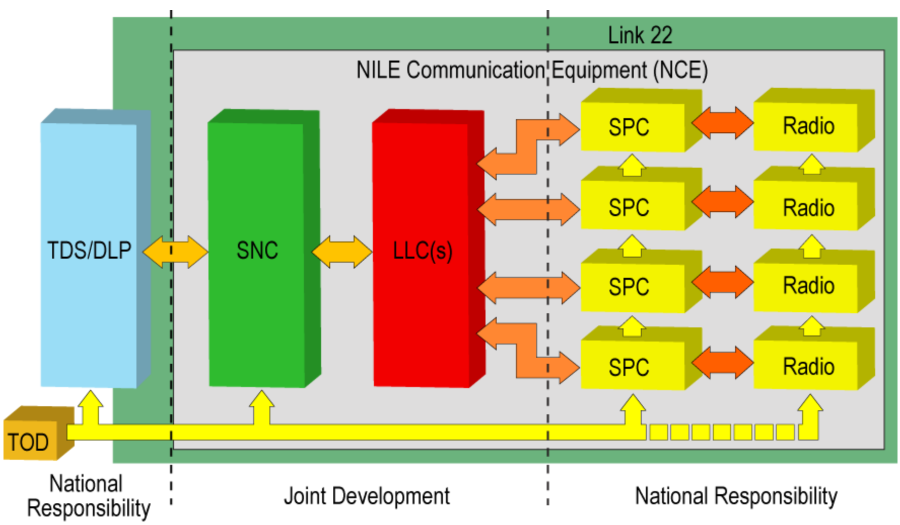
Section B Features

This section covers the following Link 22 main features.

System Architecture



The design of Link 22 uses a layered communications stack approach to produce an open system architecture, with well defined interfaces between the subcomponents.

The approach maximizes extensions and enables contributions from multiple providers.

The inner grey box in the figure indicates the **NILE Communications Equipment (NCE)** components. These components are the following.

- System Network Controller (SNC)
- Link-Level COMSEC (LLC)
- Signal Processing Controllers (SPCs)
- Radios

The Link 22 system, shown by the outer green box in the figure, consists of the NCE and the Link 22 portion of the **Data Link Processor (DLP)**. Within the DLP, this consists of the interface to the SNC and the handling of the tactical messages that it transmits and receives on the data link. The tactical messages are defined in the **NATO STANdardization AGreement** [STANAG 5522]. The DLP is connected to, or is part of, the Tactical Data System (TDS), also known as Host System of the NILE unit, which processes the received tactical messages and generates tactical messages for transmission in accordance with the unit's national requirements.

All NILE system components have been jointly defined and designed. The SNC and LLC subsystems have been commonly developed. The development of all other Link 22 subsystems is a national or manufacturer's responsibility.

Secure Communications

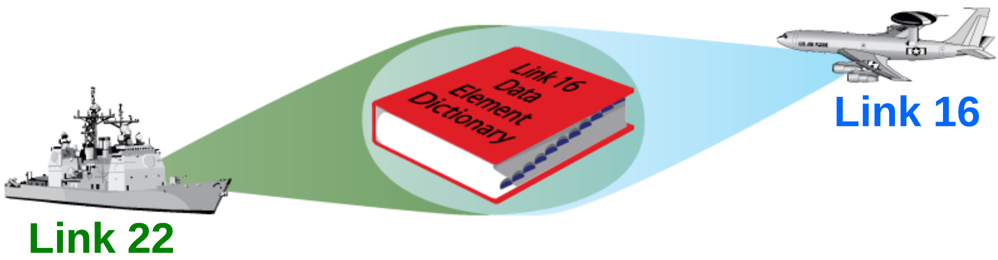
The LLC provides the system Communications Security (COMSEC). Its current configuration is a 19-inch rack-mounted hardware unit, as shown in the picture.

The LLC uses a weekly key to encrypt and decrypt the data traffic that passes through it. Two sets of keys can be loaded into the device, enabling it to operate up to 14 days without any operator intervention. The next week's key can be loaded at any time during the current week. Detailed information on the crypto key management is contained in the Crypto Key Management Plan document.

Transmission security is provided when frequency hopping radios are used. The system is capable of using frequency hopping radios in both the HF and UHF bands.

Tactical Messages within Link 22 are handled as sealed envelopes and the system works without access to the tactical data contents. This provides the possibility to encrypt the tactical data at the top level and still be able to transmit it. This additional level of security cannot be provided by Link 16 as the terminal must retain access to the tactical data being transmitted.

Tactical Message Transmission



Link 22 transmits tactical data in fixed format messages, and uses the same data element definitions as Link 16. This provides standardization between the two tactical data links. Tactical messages are composed of from one to eight **Tactical Message Words (TMWs)**. Each TMW is 72 bits in length.

Link 22 messages are called F-Series messages and are part of the J-Family of messages. The F-Series consists of two types of messages, the Unique F messages and the FJ messages. The Unique F-Series messages are more compact versions of Link 16's messages, or messages that do not exist in Link 16. The FJ messages encapsulate Link 16 J-Series messages within Link 22 messages, enabling Link 16 tactical messages to be transmitted without modification within Link 22.

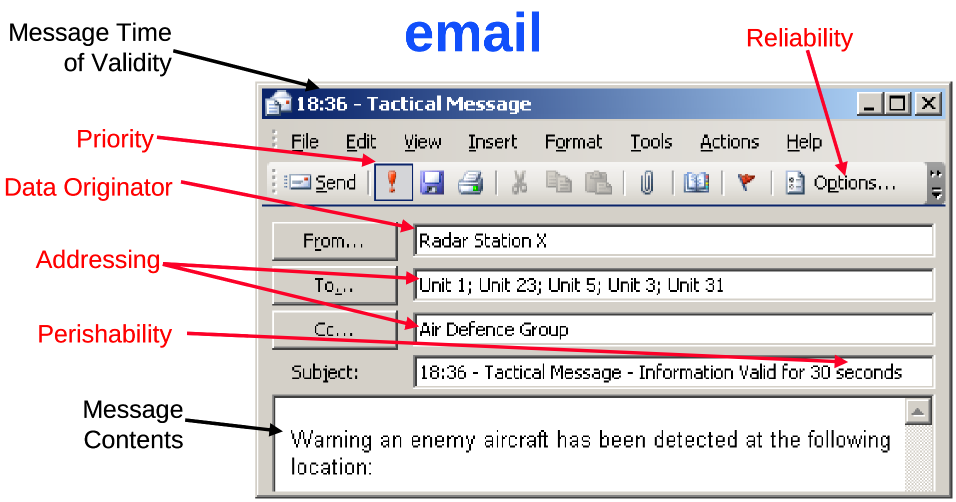
The DLP requests transmission of a Link 22 tactical message with a **Transmission Service Request (TSR)**. Each request for transmission utilizes a unique identifier and defines the required Quality of Service (QoS).

The DLP creates the Link 22 tactical messages from tactical data and the defined transmission requirements of [STANAG 5522]. Alternatively, the tactical messages may be created by the TDS and then passed to the DLP. The DLP, however, is the component responsible for passing all Link 22 tactical messages to be transmitted to the NCE. Likewise, the DLP is the destination for all tactical messages received by the NCE. The DLP may perform limited processing of the received tactical messages or may simply pass them on to the TDS for processing. Each message, as mentioned above, can be defined with different QoS.

The DLP performs other tactical functions, such as track management, correlation, reporting responsibility, conflict resolution, data filtering, and data forwarding

[STANAG 5616 Volume II] and [STANAG 5616 Volume III]. These functions are a national responsibility, and they may be performed either by the DLP or the TDS. The DLP can perform minimal tactical message processing, or it can be a complete multilink Command and Control (C2) system.

Quality of Service



Link 22 provides a number of QoS features that are specified in the TSR. These features enable the efficient use of available resources. QoS features include the following.

- Priority
- Reliability
- Data Originator Identification
- Perishability
- Indicator Flags
- Addressing

☐ *Priority*

Link 22 provides four levels of Priority (1-4), where priority 1 is the highest and 4 is the lowest. Priority 1 requests can also utilize the Priority Injection Indicator Flag, which has the effect of increasing the priority by moving the request to the top of the priority 1 queue and eligible for early additional transmission in a Priority Injection timeslot, if available. TSRs are considered during packing for transmission in a timeslot in highest priority, oldest TSR order.

☐ *Reliability*

The required reliability of the destination unit receiving the message is included with each tactical message to be transmitted. Three levels of reliability are provided: **Standard Reliability** has an 80 percent probability of reception, **High Reliability** has a 90 percent probability of reception, and there is also a **Guaranteed Delivery** protocol. The probability of reception requested is used to calculate how many repeat transmissions are made. Reliability Protocols remove the need for redundant transmissions by the DLP. The Guaranteed Delivery protocol minimizes the repetition of transmission based on the acknowledgements received.

☐ *Data Originator Identification*

The originator of the data to be transmitted is provided in the TSR. The Link 22 system ensures that this Data Originator Identification is delivered along with the data, so that any unit receiving it knows which unit originated the data regardless of its route through the system.

☐ *Perishability*

Four levels of message perishability are provided by the system, and the TSR specifies which level applies to the data to be transmitted. Perishability allows the definition of how old the data can be before it is no longer relevant, and the Link 22 system ensures that data that has perished is not transmitted.

☐ *Indicator Flags*

There are two indicator flags.

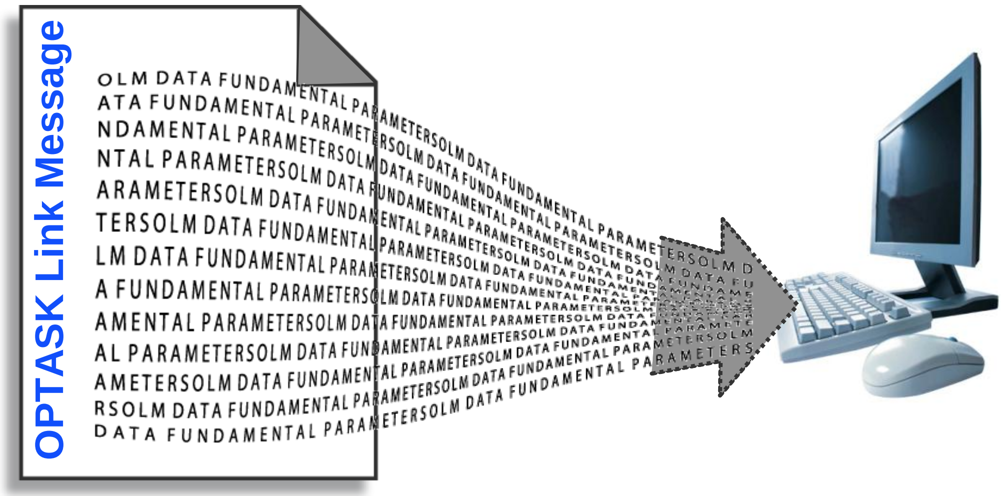
- The Priority Injection Indicator flag is used to enable priority 1 messages to be injected in **Priority Injection (PI)** timeslots, which are timeslots that are not allocated to any specific unit
- The **Radio Silence Override Indicator** flag enables the message to be transmitted when the unit is in radio silence

☐ *Addressing*

Two different Addressing services are provided, with and without Acknowledgement, which can usually be used at the same time. For both of these services, there are five types of addressing available.

- **Totalcast**: All link 22 units
- **Neighborcast**: All Radio Frequency (RF) neighbors on each NILE Network on which the NILE unit operates
- **Mission Area Sub Network (MASN)**: A logical group of units that has been previously defined
- **Dynamic List**: A list of two to five units that are specified in the request
- **Point-to-Point**: A single unit that is specified in the request

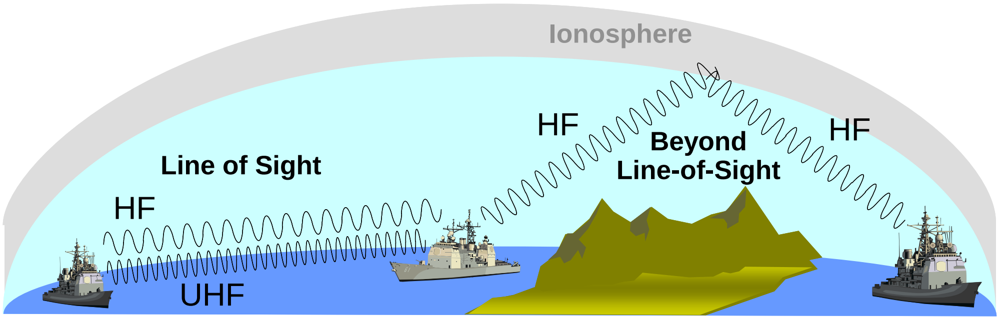
Fundamental Parameters



Link 22 requires each unit to initialize with the same fundamental parameters as all other units. This is fundamental to the operation of the system. It significantly reduces the amount of configuration data to be distributed by the system. These fundamental parameters are supplied to each unit in the Operational Tasking (OPTASK) Link Message (OLM), which is provided to the TDS. The fundamental parameters must be supplied to the SNC by the DLP during SNC initialization. This data is maintained within the SNC and is referred to as the Super Network (SN) Directory.

The generation of the OLM is performed by network planners, who take into account many pieces of information, such as the location of the operations, how many units are expected to participate, the expected tactical message throughput of each unit, and so on. The planners also consider which other tactical data links will be involved. They understand the complete communications infrastructure and define where and how Link 22 is to be used.

Media



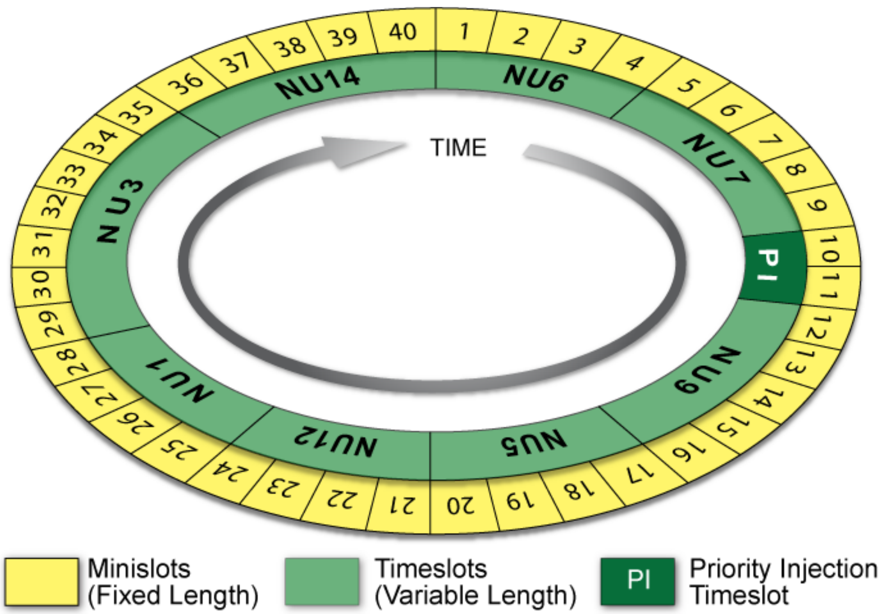
Media using High Frequency (HF) in the 2-30 MHz band provides Beyond Line-of-Sight (BLOS) communications, optimized for (but not limited to) transmission up to 300 nautical miles. Media using Ultra High Frequency (UHF) in the 225-400 MHz band provides Line-of-Sight communications only. Within both bands, either fixed frequency or frequency hopping radios may be employed, for a total of four different media types.

- HF Fixed Frequency
- UHF Fixed Frequency
- HF Frequency Hopping
- UHF Frequency Hopping

Each media has one or more different settings, which use different modulation and encoding schemes. Along with the fragmentation rate, these factors determine the number of bits per network packet that are available for transmission, which ranges between 96 and 1824 bits, as can be seen in the following table. The duration of a UHF Frequency Hopping Media Coding Frame is a classified number, and is shown by the notation “<CN>” in the table.

Media Type	Media Coding Frame (ms)	Media Settings	Fragmentation Rate	Network Packet Size (bits)
HF Fixed Frequency	112.5	1-6	1-3	168 - 1368
UHF Fixed Frequency	48	1	1-3	608 - 1824
HF Frequency Hopping	112.5	1-4	1	96 - 240
UHF Frequency Hopping	<CN>	1-4	1	464

Network Cycle Structure



The Network Cycle Structure (NCS) defines the TDMA protocol for each NILE Network. Time is divided into fixed length periods called minislots, the duration of which varies according to the media type. Periods of time called timeslots are an integer number of minislots, which may be of different size within specific limits. A timeslot is either allocated to a specific NILE unit, or is a Priority Injection timeslot. A unit may only transmit in its allocated timeslot(s), or for certain high-priority messages it may also transmit them in a Priority Injection timeslot. This ensures that each unit has an opportunity to transmit at least once within a given period of time, called the Network Cycle Time (NCT).

The NCT is the number of minislots that form the network cycle (sum of the length of all timeslots). The NCT in the above figure is 40 minislots; however, this can vary up to a maximum of 1024.

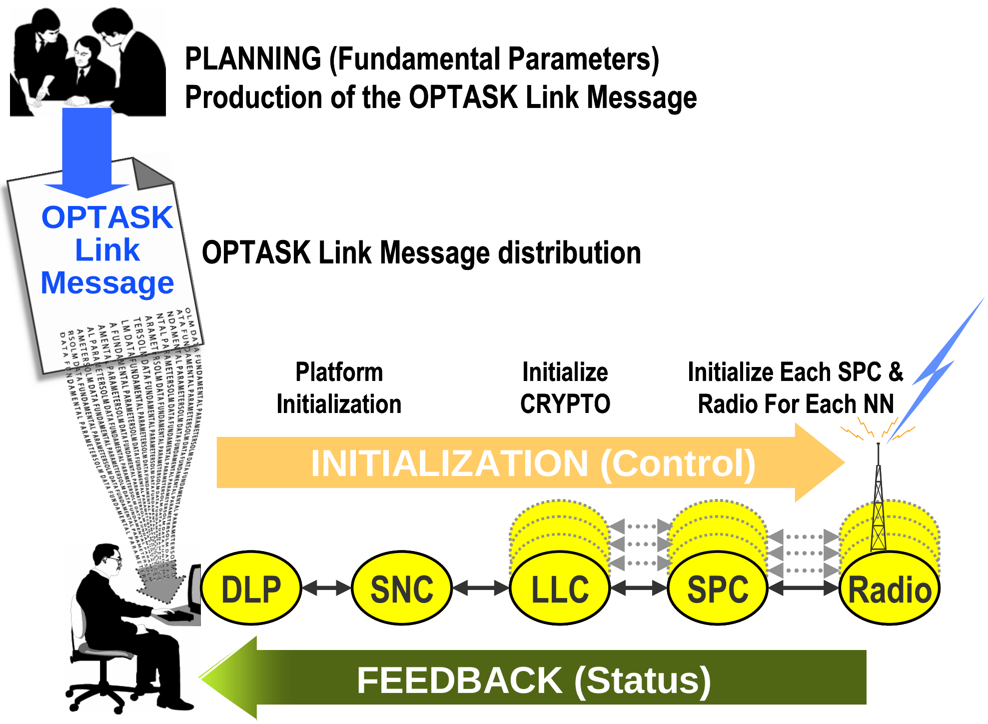
When a network is operational the NCS is referred to as the Operational NCS (ONCS). Link 22 has the ability to modify the ONCS. This capability is called Dynamic TDMA (DTDMA). The SNC can also modify the ONCS by supplying a new one.

An NCS can be defined by the planners in the OLM. The planners take into account how many tactical messages per second a unit will need to transmit (Capacity Need), including relay traffic, and how long it can wait between transmissions (Access Delay). When the NCS is defined in the OLM, the DLP will initialize the network with the supplied NCS, which will then become the Operational NCS.

The SNC can also compute an NCS, in which case the Capacity Need and Access Delay of each unit in the network must be supplied. The SNC also uses two other parameters (Tolerance and Efficiency) in its computation, which enables the generation of an optimized NCS that does not meet all the input Capacity Need and Access Delay when it is physically impossible to do so.

Media types, media setting, and fragmentation rates all affect the size of timeslots in an NCS.

Initialization



Every unit in the Link 22 Super Network uses the same Fundamental Link 22 Parameters to perform initialization. These parameters are specified in the OLM. This significantly reduces the volume of configuration data that needs to be distributed by the system. In fact, Link 22 can be initialized and can transmit tactical messages on a NILE Network at the instant the network is to start, with no prior communications on the network required.

Initialization consists of the following two parts.

- NILE Unit Initialization
- Network Initialization

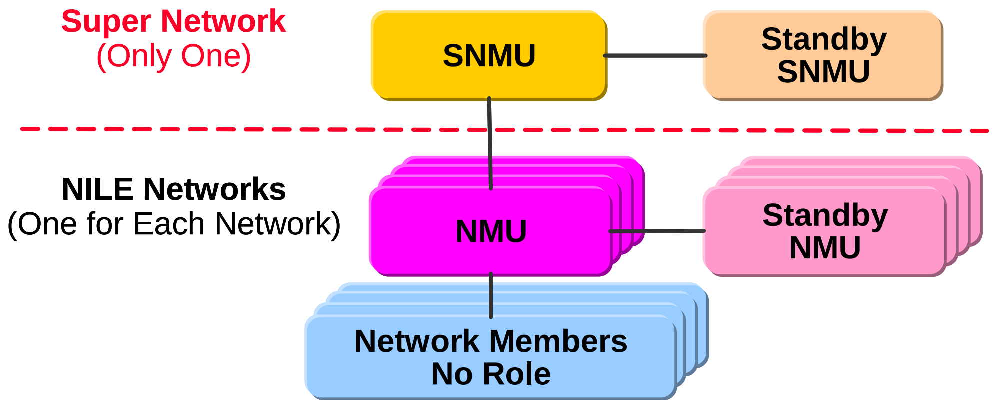
The Link 22 unit's subsystems must be initialized first, before it can initialize any networks. Hardware configuration information must be supplied to the SNC by the

DLP. The DLP also must supply the Fundamental Link 22 Parameters so that the SNC can initialize its internal data.

When SNC Initialization is complete, the DLP can begin to initialize the individual NILE Networks. The OLM can specify one of the two types of initialization; either quick initialization (known as Short Network Initialization) or an initialization that requires probing of the environmental condition before allowing for tactical traffic to be generated (known as Initialization with Probing). Short Network Initialization can use an NCS defined in the OLM or let the SNC calculate the NCS based on the Capacity Need and Access Delay parameters described above.

If the unit has missed the start time for the network initialization, it should join the network by performing the Late Network Entry (LNE) protocol. Late Network Entry (LNE) provides the unit with the current parameters, which may have changed since the network was initialized.

Network Management



Link 22 was designed, using lessons learnt from Link 16 experience, to operate with automated and simple management. The result is that it is significantly easier to plan and operate than either Link 11 or Link 16.

Link 22 has automated Network Management functions that require a minimum of operator interaction, if any. These functions are controlled by the transmission of Network Management messages. Each unit can define whether or not to automatically respond to, and whether or not to automatically perform, each of the Network Management functions.

Link 22 specifies two network management roles. For each role, a standby unit automatically takes over the role, if the unit performing or assigned that role fails. The new management unit immediately nominates a new standby unit. The system will therefore continue operation without the presence of units originally nominated to perform these management roles, and will operate even if no units are performing the roles. After the Link 22 system has started, the Super Network Management Unit (SNMU) has overall management responsibility for the entire Super Network. The Network Management Units (NMUs) have management responsibility only for their particular NILE Network. The SNMU can order the NMUs to perform their network management functions. The SNMU can be the NMU for the networks that it is active on. A NMU may be the NMU of more than one network.

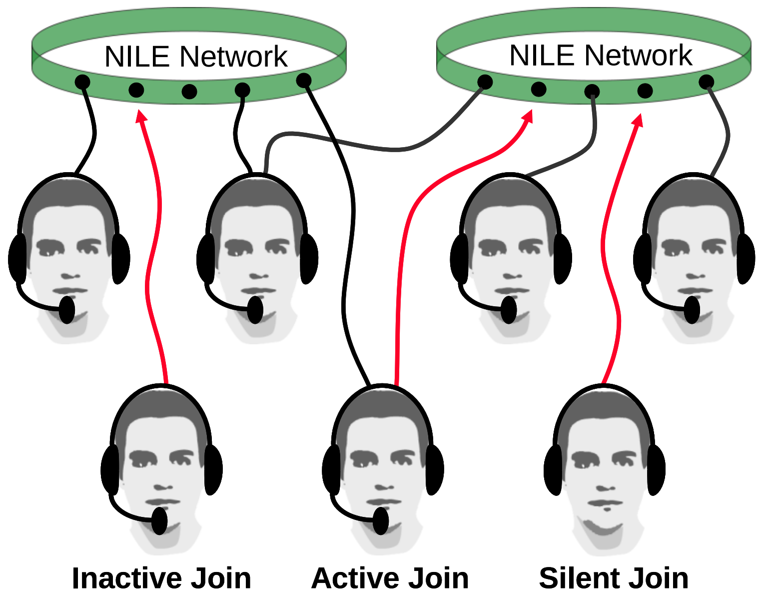
The SNMU and, in some cases the NMU, can order certain management changes to the Link 22 system, including the following.

- Starting a new NILE Network
- Shutdown of a NILE Unit
- Shutdown of a NILE Network
- Shutdown of the entire Super Network
- Optimization of network performance
- Controlling Management Roles
- Joining a network
- Managing Radio Silence Status
- Managing Crypto Key Status

Other management functions do not require the use of an order, but do require transmission of a message to initiate the change.

- Managing Radio Power
- Managing the Super Network Directory
- Reporting monitoring data
- Reporting statistical data

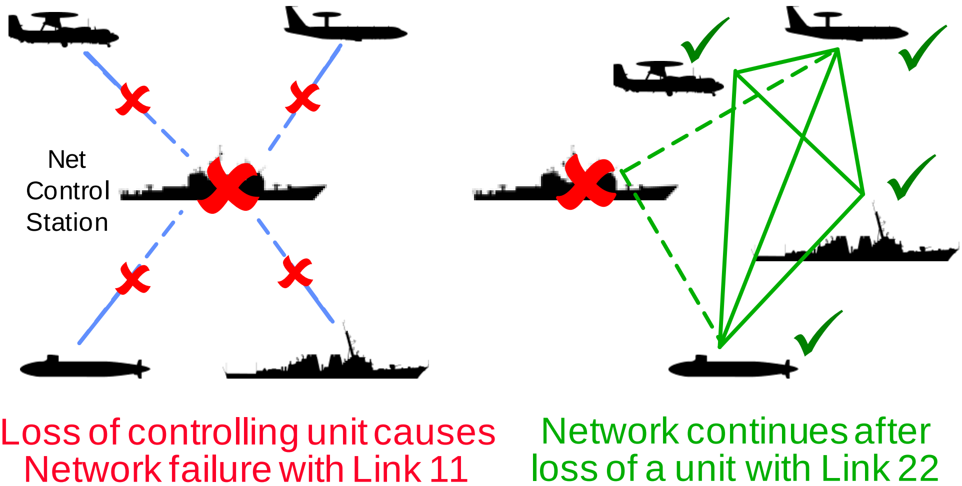
Joining a Network



A unit that arrives after the Super Network has been started can still join by initiating the Late Network Entry (LNE) protocol. This protocol provides the unit with the most current parameters necessary to join the network. The protocol is initiated by the operator and is usually fully automatic, with the protocol's progress available to the operator. A NILE unit may join a network in one of the following three ways.

- **Inactive Join**: the unit wants to join a network when it is not an active member of any NILE Network
- **Active Join**: the unit wants to join a network when it is already an active member of at least one other NILE Network
- **Silent Join**: a unit that is not an active member of any NILE Network and wants to listen to the network without making any transmissions

Resilience



The Link 22 system is designed to be resilient. If faults occur, it manages them and attempts to continue operating. A unit participating on multiple NILE Networks can have a failure on one network while continuing to operate on the other networks. A unit is able to handle the closure or shutdown of a network and the restart of the network after the hardware has been reset, without affecting the other networks.

When the connectivity changes, possibly due to the loss of a unit or the failure of equipment, the relay automatically takes this into account and modifies message routing in an attempt to maintain the probability that messages get to their addressees.

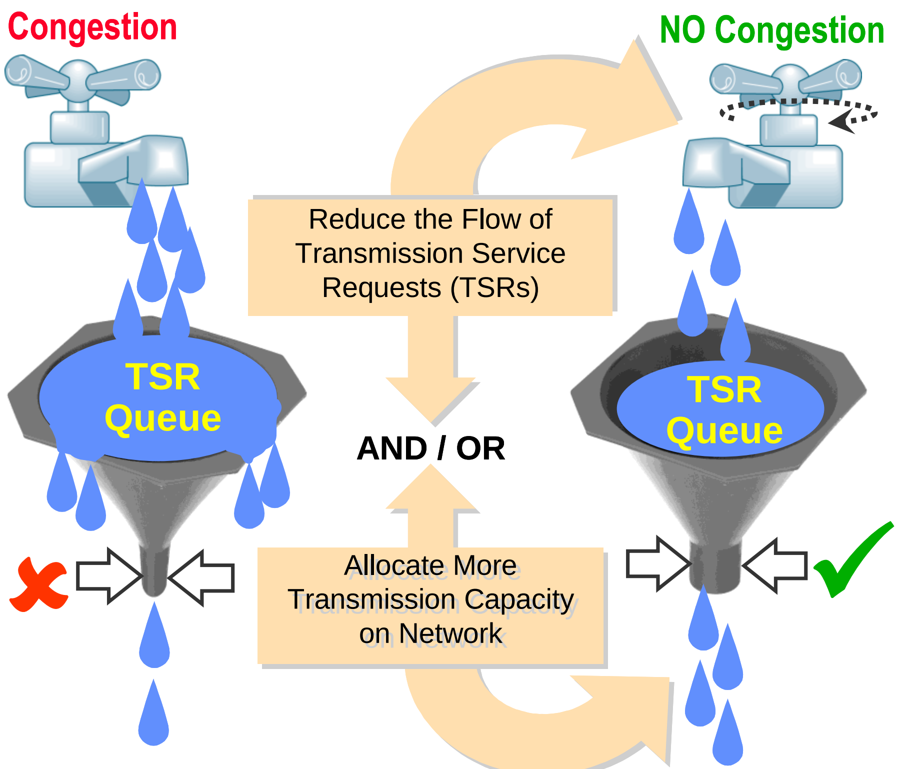
Link 22 automatically retransmits messages to ensure that the requested quality of service (Reliability) is achieved whenever possible. This removes the need for the DLP to perform redundant transmissions and minimizes bandwidth utilization. Retransmissions are always placed in different packets on the network so that the loss of a single packet cannot cause the loss of all repeated transmissions.

The transmission on the NILE Networks is controlled by the TDMA structure, which is known to each unit, so the loss of any unit does not affect the ability of the remaining units to continue operation. Virtually all functions work in this manner (called distributed protocols), so there is no single point of failure.

Some units perform special roles, but the loss of these units is not disastrous to the operation of Link 22. Any unit that is performing one of the special roles must ensure that it always has a standby unit available to take over the role in case the unit is lost or its Link 22 system fails. A Standby that takes over a role must ensure that a new standby is defined. Messages are exchanged between units, and the loss of reception from the role unit will cause its standby to activate the **Role Takeover** protocol. Similarly, if the role unit loses reception from its standby, it will give the standby role to another unit.

Troubleshooting at the unit, network, or Super Network level is enabled by the reporting of monitoring and statistical data. Each unit’s SNC also validates all message data sent to it by the DLP before processing the message, and reports success or failure of each message back to the DLP. If the validation fails, the SNC also provides details of why the message failed validation.

Congestion Management



Congestion Management is performed automatically in a number of ways. Message routing will use alternative paths to minimize congestion. When Dynamic TDMA (DTDMA) is enabled, a unit that is not congested can donate spare transmission capacity to a congested unit. This affects the allocation of timeslots within the ONCS, but does not affect the NCT. All of this occurs automatically, with no operator or DLP actions required.

The NMU can change the ONCS to redistribute capacity. This function, called **Network Reconfiguration,** causes little or no network interruption. The NMU provides or causes the SNC to generate a new NCS, which can have a different NCT. On successful reconfiguration the NCS becomes the new ONCS.

Media parameters can be modified by the NMU in an attempt to increase the available capacity of the network. This requires the network to be temporarily paused and reinitialized with new parameters, which causes a minor interruption of network operations. This procedure is called **Network Re-Initialization**. The NMU can optionally provide or causes the SNC to generate a new NCS, which can have a different NCT. On successful Re-Initialization the NCS becomes the new ONCS.

Unit congestion arises from two sources: the messages the DLP requests to be transmitted, and the messages received from other units that must be relayed to ensure that the messages are received by their addressees. The DLP has full control over messages it has requested to be transmitted. The DLP could delete selected requests to reduce the congestion, and it could reduce the rate of transmission requests.

Tactical messages that are being relayed are normally not under control of the DLP. In cases of high congestion, however, the DLP can be informed of the relay messages and decide whether it wants to delete any. This last resort reduces the congestion, but it also affects the delivery of messages. This decision process is called **Relay Flow Control**.

Section C Benefits

Link 11 is an old tactical data link that does not offer the capabilities and performance required by today's operational community. Link 16 is a complex and robust tactical data link that attempts to meet current operational requirements but is still reasonably old technology. It does not offer recently derived operational concepts, requires extensive planning and is difficult to manage.

Link 22 offers the latest technology and uses COTS products. It provides a simple-to-use, sophisticated suite of functions that require minimal operator interaction, and that enable it to be used as both an excellent stand-alone tactical data link or in a complementary role with Link 16. Link 22 significantly enhances NATO tactical data link capabilities and meets today's increasing need for successful interoperability within allied operations.

Comparison with Link 11

Link 11 has been in existence since the mid-1950s. It was conceived to support small numbers of units performing mainly an Anti-Air Warfare (AAW) role on a single network. In normal use (Roll Call) a Link 11 network is controlled by a Net Control Station, which polls each unit in turn to request a transmission. When each unit is polled, it transmits its data without prioritizing the data, so no unit can be polled until the current transmitting unit completes its transmissions. A unit cannot transmit until it is polled.

Link 22 was designed primarily as a maritime tactical data link for anti-surface and subsurface warfare, although, like Link 16, it supports all battle environments. A comparison of Link 11 to Link 22 follows.

Link 11	Link 22
Roll Call Transmission allocation. Increased net cycle times due to increasing numbers of Participating Units (PUs) and tracks. Large access delay	Uses TDMA which provides deterministic access to the network. Prioritization of messages ensures most important are transmitted before less important
No way to transmit urgent information	The use of Priority Injection timeslots in the TDMA structure can be used to minimize the delay in the transmission of urgent information
Limited number of participants (62)	More units (125)
A restrictive “playing area” based on the ranges of individual platforms, and more importantly, on its method of reporting its position, and that of its tracks, based on its distance from a Data Link Reference Point (DLRP). These factors limit the use of Link 11 in extended areas of responsibility, and also prevent polar operations	Uses the Worldwide Geodetic System (WGS-84), same as Link 16, so no limitation. Each NILE unit can operate simultaneously on up to four networks; a Super Network can be composed of up to 8 networks. This flexibility greatly increases the playing area

Link 11	Link 22
All units have to be in RF connectivity with the Net Control Station, again limits the area of operation	The use of routing & relay protocols greatly increases the playing area, even when using line-of-sight UHF
Relatively easy to spoof because of weaknesses in the security of the system	More difficult to spoof, and any attempts to spoof are easier to detect, due to features such as time based encryption
Relatively easy to jam a single HF or UHF fixed frequency network	A single HF or UHF fixed frequency network can still be jammed, however with multiple networks it is more difficult to jam all at the same time. The use of frequency hopping media makes it significantly more difficult to jam
The encryption level is not sufficient for the processing power of modern computers	Uses same crypto chip as Link 16. Crypto technology is being updated to meet future requirements
The loss of the Net Control Station will cause the network to collapse	Does not use a Net Control Station. Designed with no single point of failure
The accuracy of Link 11's M-Series messages is inadequate for modern targeting	Data items are designed with improved ranges and granularity using same data dictionary as Link 16
Available waveforms limit communications under bad RF conditions (as occur in polar regions)	A variety of more robust waveforms. In bad conditions strong coding can be used to maintain communication at the expense of throughput
M-Series messages difficult to translate making data forwarding between links complex	Link 22 is part of the J-Series family of messages, uses the same data dictionary as Link 16 and so makes translation and forwarding relatively easy compared to Link 11
Limited Bandwidth (1,800 bps for fast and 1,090 bps for slow)	Range of bandwidths available depending on coding and media for example fixed frequency: HF 1,493 – 4,053 bps UHF 12,666 bps

Comparison with Link 16

The more modern and complex Link 16 is primarily an AAW tactical data link, although it supports all Environment types. Link 22 is primarily a maritime tactical data link and has been designed to complement Link 16 operation.

Link 16 supports a single network with a large number of units spread across multiple frequencies (stacked nets). The stacked nets can be organized by unit types and tasks. There are peacetime restrictions on the use of certain frequencies.

Link 16	Link 22
UHF is LOS only. Link 16 units require airborne relay support to increase the range of network connectivity. Airborne relays are not required, however, for satellite Link 16	Provides BLOS communication with both HF and HF/UHF automatic relay which is not dependent on airborne relay units being available. It remains operable when an airborne relay is not available
UHF fast frequency hopping counters the effects of jamming, making it extremely difficult to jam	A single HF or UHF fixed frequency network can be jammed, however with multiple networks it is more difficult to jam all at the same time. The use of frequency hopping media makes it significantly more difficult to jam
Network Management is very complex to plan and operate	Network Management is highly automated, relatively simple and includes features such as dynamic bandwidth allocation
J-Series family message standard	J-Series family message standard
15-bit Participant address numbering	Same as Link 16
19-bit track numbering	Same as Link 16
Worldwide Geodetic System (WGS-84)	Same as Link 16
Data transfer rate is between 26,880 and 107,520 bits per second, depending on the data packing structure	UHF fixed frequency data transfer rate is 12,666 bits per second. Link 22 can have multiple networks which can increase the bandwidth

Data Transfer Rate Comparison

The raw (maximum) data rates (Bits Per Second (bps)), shown in the figures are what is available for Tactical Data transmission, after the low level overheads (Error Detection And Correction (EDAC) bits, synchronization bits, etc.) have been taken into consideration.

Link 11 HF/UHF	**Link 16 JTIDS**	**Link 22 HF (fixed frequency)**	**Link 22 UHF (fixed frequency)**
1090 or 1800	26,880-107,520	1,493 – 4,053	12,666

Link 22, unlike Link 11, can perform simultaneous different transmission on up to 4 networks, which increases bandwidth. Two typical configurations are shown below.

3 HF AND 1 UHF (fixed frequency)	**2 HF AND 2 UHF (fixed frequency)**
24,825	33,438

Link 22 complements Link 16 by providing additional bandwidth in other frequency ranges and in particular by providing the BLOS and automatic relay capabilities.

Section D Acquisition

It can be seen from the Link 22 architecture that the following components need to be acquired to add the Link 22 capability to a platform.

- Operator Interface System (TDS/DLP)
- SNC Processor Hardware
- Link-Level COMSEC (LLC)
- Signal Processing Controller (SPC)
- Radio System
- Time Of Day (TOD) Source Hardware
- Connecting Cables and Equipment
- Spares

Each listed item will be discussed further. Logistics spares also need to be acquired to provide an adequate level of cover in case of unit failure.

Operator Interface System (TDS/DLP)

The Data Link Processor (DLP) is connected to, or is part of, the Tactical Data System (TDS) of the NILE unit. The DLP processes the received tactical messages and generates tactical messages for transmission in accordance with the unit's national requirements.

If Link 22 is to be added to an existing operator interface or TDS, it may be possible to incorporate the Link 22 TDS/DLP functions within the existing system; otherwise, a new processor will be required to run the functions. However, if the existing system has spare link interfaces, it may be possible to connect Link 22 to the existing system using a spare link interface. In this case, a gateway system that converts from the existing link format to Link 22 would need to be purchased.

SNC Processor Hardware

The SNC software requires a computer processor to execute the code. This would usually be Personal Computer (PC) type hardware, either running Windows XP or Linux operating systems. The SNC software is written in Ada 95 and is easily portable to other platforms as long as there is an Ada 95 compliant compiler available on the platform. The computer does not require significant processor power and any available current technology processor is sufficient. As a guide, a 1GHz processor with one GByte of memory is more than adequate. The processor needs to support at least one Ethernet connection (preferably 100 Mbps) but, depending on the configuration, two may be required. The processor requires some storage for the operating system, the SNC executable and the TOD interface software. Possible configurations include a VME backplane enclosure with power supply and a VME processor card, or a rack mountable industrial PC.

Link-Level COMSEC (LLC)

A single LLC can handle multiple networks depending on the type of media. The system can use a maximum of four LLCs which would be one LLC per network, but this would be an unusual configuration. A typical system will only use a single LLC. If more than two UHF Networks are deployed, two LLCs are needed. Associated with the LLC and its key loading, a Data Terminal Device (DTD), which is used to load the keys into the LLC, would need to be acquired from the national crypto agency. Depending on the method of key distribution employed, a paper tape reader KOI-18 may also be required. It is possible to distribute encrypted keys as PC files, in which case a special serial cable would be required to load the file from a PC into the DTD.

The current LLC is a 19” rack mountable unit. The manufacturer refers to the LLC as the KIV-21/LLC.

Signal Processing Controller (SPC)

An SPC is required for each network/media that the unit is required to operate on. A single SPC may be configured to use different media. An SPC hardware unit may contain more than one SPC. At the time this book was written, there were three manufacturers of SPCs, which all supported HF and UHF Fixed Frequency media. Frequency hopping media is also supported either within a separate SPC or embedded within a frequency hopping radio. The fixed frequency HF and UHF SPCs were available in 19” rack mountable chassis, with two of them containing VME cards which could be mounted in a suitably configured VME backplane.

Radio frequency and power control by the SPC is optional. Refer to the SPC manufacturers’ specifications to determine the options that are available with the supported radios.

Radio System

The appropriate radio system is required for each of the media types that will be used, and consists of the following.

- Radio
- Power Amplifier and Power supply
- Antenna Tuning Unit
- Antenna
- Antenna mounting hardware and cabling infrastructure

The radio, power amplifier and power supply may be a single unit depending on the output power required. The higher the output power the more likely that separate units will be needed.

One of the goals of the NILE program was to be able to reuse existing modern Link 11 radios and antennas equipment. If they are any available this would reduces the equipment that must be acquired.

Time Of Day (TOD) Source Hardware

Link 22 needs to be supplied with coordinated universal time (UTC); which, if not already available on the platform, must be acquired.

The TOD needs to be supplied to the DLP, SNC, SPCs and frequency hopping Radios, if equipped. The recommended TOD input to the SPCs is the Extended Have Quick format as defined in [STANAG 4430].

The SNC is delivered with a separate application (Read TOD) that accepts a Brandywine Serial 485 and 1 Pulse per Second (PPS) input in compliance with [STANAG 4430]. The Read TOD can be customized to supply the SNC with the appropriate time as detailed in section 3 of the [NRS IDD]. The TDS may also require an accurate time to guarantee synchronization among all the subsystems.

If a reliable source is not available, the Global Positioning System (GPS) TOD hardware required normally consists of the following.

- GPS Antenna and mounting hardware
- Cabling from the GPS antenna to the GPS receiver
- GPS receiver and time code generator
- Connecting cables to supply time code to the system
- Time code cards for the SNC and DLP computers

Connecting Cables and Equipment

The equipment needs to be housed in suitable enclosures appropriate to the environment in which the equipment is to be installed. Whether installed in single or multiple enclosures will depend on the site and the way that communications equipment is usually configured on that platform. Each set of equipment will require power and appropriate allowance for cooling.

The components of the Link 22 architecture have to be inter-connected via appropriate cabling and communications devices.

The DLP-to-SNC interface and the SNC-to-LLC interface both use Transmission Control Protocol / Internet Protocol (TCP/IP). If TCP/IP is communicating within a processor, no cabling is required for the interface, which would be the case if the DLP and SNC were running on the same processor. When on separate equipment or processors, TCP/IP can use many types of network interfaces. The LLC interface uses Ethernet and so the SNC-to-LLC interface has to be Ethernet. Two Ethernet ports can be joined together with a simple cross-over Ethernet cable (point-to-point), or joined together using an Ethernet hub or switch. The use of an Ethernet hub is recommended to allow for monitoring of the interface. If the SNC host processor only has one Ethernet port then a single hub could be used for both the DLP-to-SNC and the one or more SNC-to-LLC interfaces.

The LLC is connected to the SPC via RS-422 serial cable.

The SPC is connected to its radio via a media specific interface, and is a national responsibility. It could even be implemented with the SPC being housed within the radio. Refer to the SPC and radio manufacturers' manuals for exact details of the interface.

Spares

Logistics spares would also need to be acquired to provide an adequate level of cover in case of unit failure. The quantity and level of spares provided is a national responsibility and may vary depending on the platform, location and the number of operational units.

Chapter 2

Link 22 Operations

Based on the technical aspects defined in [STANAG 5522] and on the basis of operational procedures as defined in NATO document, Allied Data Publication [ADatP-33] this chapter is intended as a generic guideline for planners, operators and technicians utilizing Link 22 in a single or a multiple link environment. National or platform specific procedures and operator actions are not covered in this guidebook.

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Chapter 3

Link 22 Technical

This chapter contains technical details of Link 22, consisting of the architecture, functions, and protocols. It is primarily intended for integrators, software engineers and testers. Readers of this chapter are expected to have knowledge and understanding of the previous chapters, as this chapter will explain details without reiterating the higher level information already provided. This chapter will discuss non-tactical Link 22 features, functions, interfaces, and messages. The tactical messages were discussed in Chapter 2 Section D.

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Appendix A
Integration and Test Tools

The Link 22 community recognized the need to make test tools available for the development of all components unique to Link 22.

There are two systems available.

- **NILE Reference System (NRS)**, which is used in the following ways.
  - SNC-to-SNC compatibility testing
    - Verification and Validation of requirements
    - Automated regression testing
  - LLC and SPC Verification and Validation support

- **Multiple Link System Test & Training Tool (MLST3)**, which supports the development and testing of national DLPs in the following areas.
  - Conformance to Tactical Standards
  - Interoperability, in both single and multi-link environments
  - National DLP Integration and Testing

Both systems can also be used for Link 22 training, and allow several configurations which are detailed in the following sections. Most of the MLST3 or any other Link 22 test configurations require the approved use of SNC and NRS components, the distribution of which is managed by the NILE PMO.

The collection of software and hardware components that are required to form a particular test system configuration is shown in a grey shaded area to separate the test system from the actual system being tested. This does not imply that a particular test tool provides all the components needed to form the test system configuration.

Detailed instructions on *how* to construct the various configurations can be found in the NRS System Technical Manual [NRS STM] or in the MLST3 User Manual.

To test the complete Link 22 architecture either real or simulated components are required for each of the layers of the architecture as shown in Figure A-1.

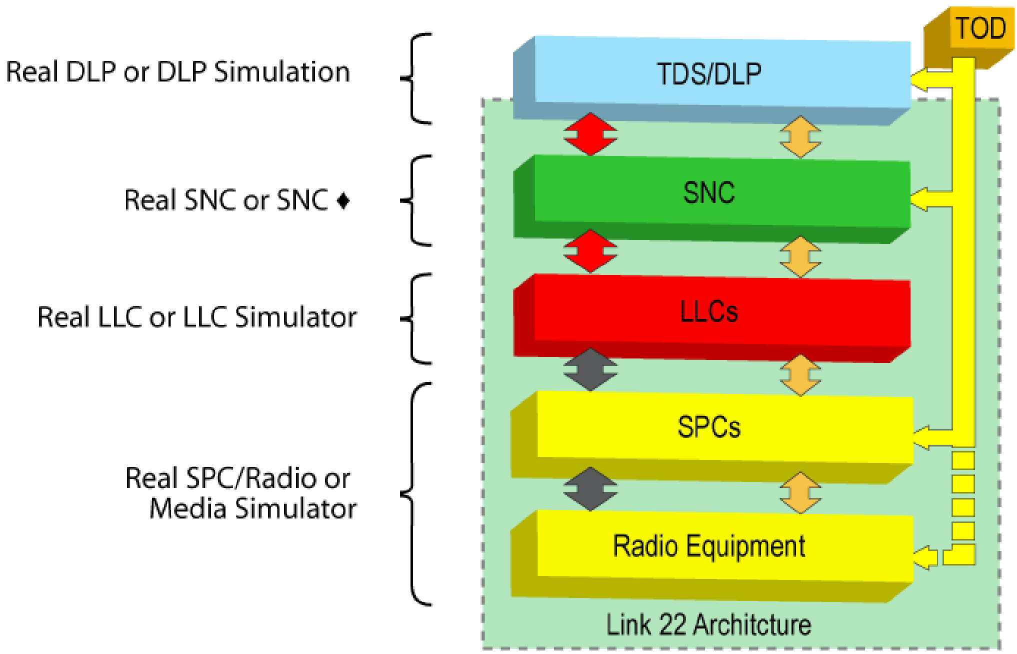

Figure A-1 Mapping of the Link 22 Architecture to Testing Components

The real SNC, the SNC♦, the LLC Simulator, and the Media Simulator are all software components, the distribution of which is managed by the NILE PMO.

A.1 NRS

The NRS is a suite of software applications and COTS hardware components designed to provide life cycle support and performance validation for the SNC, LLC and SPC. The NRS features data extraction and analysis tools which provide detailed analysis and replay capabilities. This section will cover the following topics.

- NRS Components
- NRS Configurations
- Scenario Generator (SG) Usage

A.1.1 NRS Components

The NRS consists of the following components.

- Scenario Generator
- SNC and SNC Diamond
- LLC or LLC Simulator
- Media Simulator

☐ Scenario Generator

The Scenario Generator (SG) is a collection of tools for scenario development, test execution, data recording, and data analysis that are used to prepare, execute and analyze tests with the NRS.

The NRS allows the generation of expected responses that are checked using the SG Data Analysis (DA) program. Expected Responses are messages which DA expects to see in a Data Extraction (DX) file. By comparing the messages in a data extraction file with the expected responses, DA can automatically test functionality in the SNC. This simplifies regression tests for all components.

Further details of the SG tool usage are provided in section A.1.3 Scenario Generator (SG) Usage.

☐ *SNC and SNC Diamond*

The System Network Controller (SNC) is the operational software that Link 22 uses. In the test configurations it is referred to as the Unit Under Test (UUT).

The SNC Diamond (SNC♦) is a special multi-threaded version of the SNC which can simulate up to 32 SNCs per instance. The NRS can start up to four instances of the SNC♦ to simulate all 125 NILE units. The SNC♦s do not communicate directly with any LLCs, but with the Media Simulator which uses the NRS LLCs as necessary to encrypt and decrypt data that is transmitted to and received from the UUT. Communications between simulated units that are not connected to the UUT are not encrypted and decrypted. Some queue sizes are smaller in the SNC♦, so some tests need to be performed with multiple SNC UUTs using the Multiple Units Under Test (MUUT) configuration, instead of with SNC♦s.

☐ *LLC or LLC Simulator*

The Link Level COMSEC (LLC) is described in section 3B.

The LLC Simulator provides a simulation of the LLC hardware. It is functionally identical to the real LLC and has an Ethernet connection to the SNC on one side and a serial port connection to the Media Simulator (or real SPC) on the other side. The LLC simulator only implements a simple encryption algorithm, which may produce different test results in cases where decryption would normally produce invalid data, such as during portions of Late Network Entry. Each instance of the LLC Simulator can simulate up to eight LLCs. Therefore multiple instances may be required when executing the NRS or MLST3, depending on the number of LLCs required. The LLC Simulator can replace real LLCs in all configurations described in this appendix.

☐ *Media Simulator*

The Media Simulator (MS) simulates the SPCs/Radio and the LLC Interface in some configurations. The Media Simulator provides SPC simulation for up to six SNC UUTs and can map simulated SNC♦ units to a single LLC (simulator or real), by handling all of the communication with the LLC for the SNC♦ units. MS provides the serial connections to all LLCs to simulate the LLC/SPC connection. Figure A.1-1 shows the MS providing LAN and Serial connections to an LLC for the SNC♦.

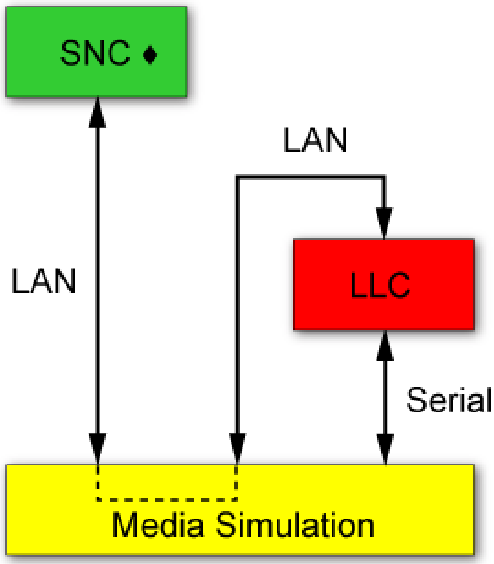

Figure A.1-1 SNC♦ to MS to LLC Connections

The Media Simulator is part of the NRS but also supports MLST3. It has some differences depending on which system it is used in. The system functionality to use is selected in the MS initialization file.

For the NRS, MS provides SPC simulation for one UUT and four SNC♦s or up to five UUTs. For MLST3, MS provides the capability to have combinations of real and simulated SPCs, for one SNC♦ and up to five UUTs, with a maximum of four units using real SPCs. Real and simulated SPCs cannot be combined on the same network.

A.1.2 NRS Configurations

The NRS configurations are the following.

- SNC Verification
- Multiple Units Under Test (MUUT)
- System Simulation
- Media Simulator (MS) Standalone

☐ SNC Verification

SNC Verification is the primary NRS configuration used to verify the functionality of the SNC. SNC Verification involves a single SNC UUT being tested with up to 124 simulated units. The media connectivity is provided by the Media Simulator. Figure A.1-2 depicts the NRS in SNC Verification mode.

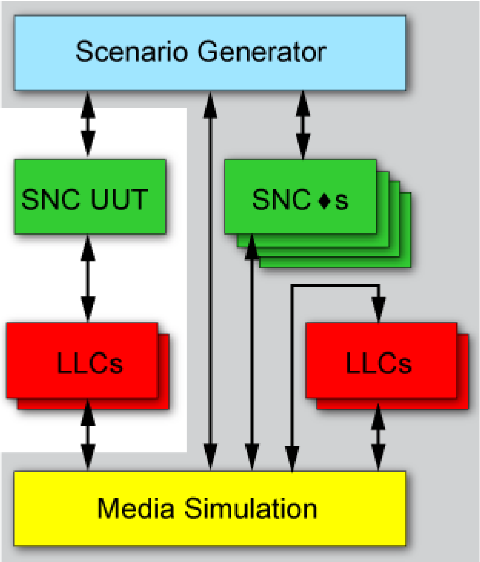

Figure A.1-2 NRS in SNC Verification mode

☐ *Multiple Units Under Test (MUUT)*

The NRS Multiple Units Under Test (MUUT) configuration provides the ability to test between two and five real SNCs (UUTs), without the use of simulated units. This configuration also tests the functionality of the LLC. The normal configuration uses the Media Simulator. The purpose of this configuration is to ensure fidelity of testing between real SNCs, not between real and simulated SNCs. Functionally the NRS starts the real SNC software in place of one of the SNC♦s for the fifth UUT. Figure A.1-3 depicts the Multiple Units Under Test (MUUT) configuration of the NRS.

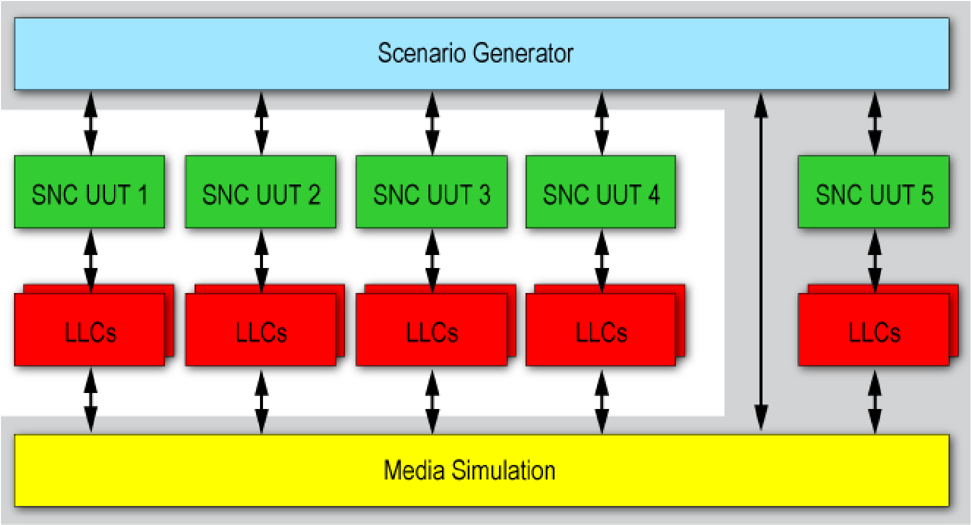

Figure A.1-3 NRS in Multiple Units Under Test mode

This configuration can also be used to test real SPCs or real SPCs with Radios (where MS is not used). If radios are not used then a simulated connection between SPCs has to be provided. For two units this can be a simple back to back wire connection between SPCs. When more than two units are used, there has to be one-to-many connectivity, which can be provided by a COTS matrix switch. Figure A.1-4 shows an example of this configuration (the maximum size), with the use of real radios.

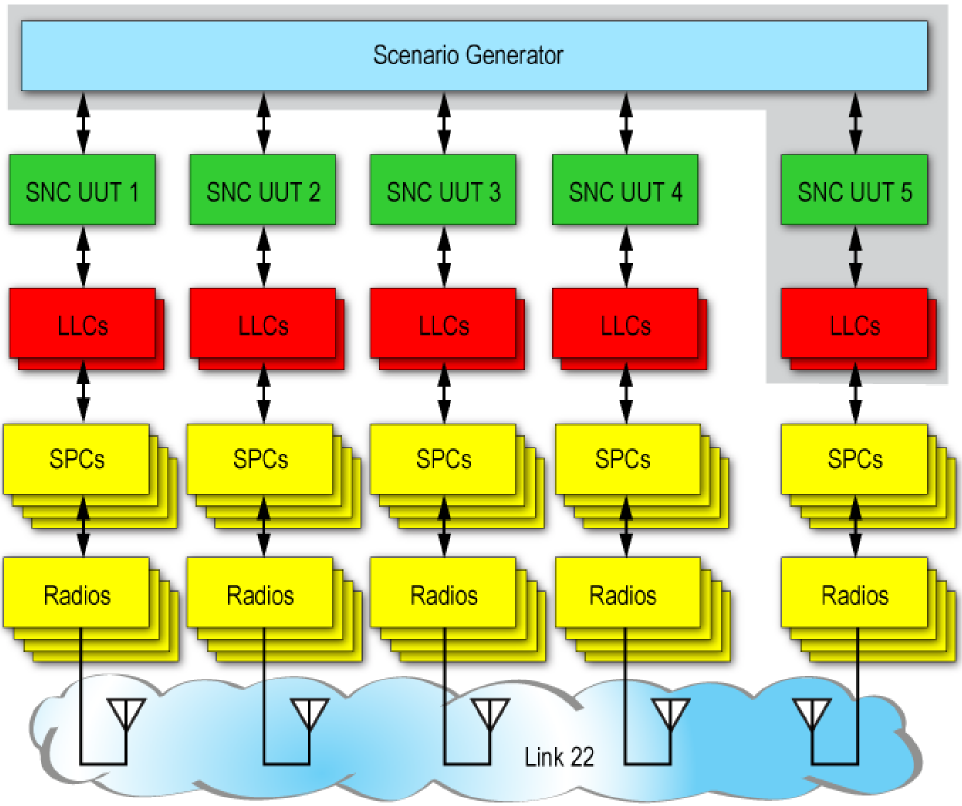

Figure A.1-4 NRS MUUT Used for SPC and Radio Testing

☐ *System Simulation*

The System Simulation configuration is used to validate NRS test scenarios. This configuration uses multiple computers to ensure that sufficient computer resources are available, especially when running stress test scenarios. System Simulation involves only units simulated by SNC♦. In this configuration the Media Simulator also simulates the LLCs. System Simulation can support 1-125 simulated units in real time, or up to 25 units running a simulation at four times (4X) normal speed. This configuration is shown in Figure A.1-5.

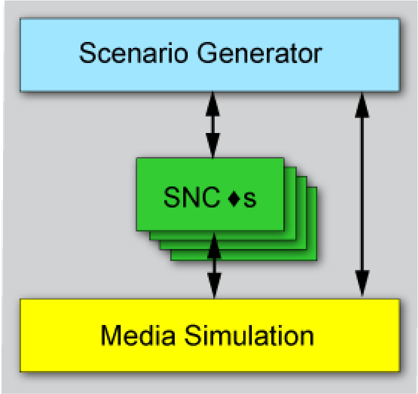

Figure A.1-5 NRS in System Simulation mode

The NRS can run in System Simulation mode entirely on a single computer (a "Single Computer NRS"). NRS versions 9.3 and below do not provide any data extraction capabilities when run on a single computer. In addition, this configuration may not be suitable for stress test scenarios. As computers become more powerful the performance may no longer be an issue.

☐ *Media Simulator (MS) Standalone*

The MS Standalone configuration allows the testing of a national DLP without using real SPCs, which are replaced by the Media Simulator. The SG Server is used to initialize the Media Simulator with the appropriate media settings and network parameters. After the initialization has been completed, the SG Server can be terminated and the Media Simulator will await connection from the SNCs. Figure A.1-6 shows the MS Standalone mode of the NRS, using two units back to back. Note that there could be up to five units.

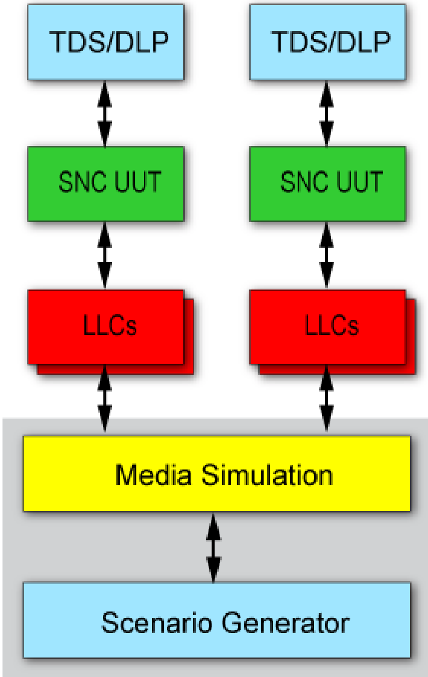

Figure A.1-6 NRS in MS Standalone mode with two units

A.1.3 Scenario Generator (SG) Usage

The Scenario Generator ("SG") component is used in three phases of the NRS. The three phases of the NRS and their corresponding SG programs are listed below.

- Pre-Test
  - Scenario Developer (SD)
  - Scenario Generation (SG)

- Test Execution
  - SG Server (SGSV)
  - SG Workstation (SGWS)
  - SG Extractor (SGEX)

- Post-Test
  - Data Reduction (DR)
  - Data Analysis (DA)

☐ *Pre-Test*

The Pre-Test phase consists of creating a text Scenario File (.SO) and using the Scenario Generation program to produce a binary Scenario File (.SF) from the .SO file. The text based .SO file can either be manually written with any standard text editor, or can be generated using the Scenario Developer's graphical user interface, or extracted from a pre-existing scenario file repository. Scenario Generation generates two output files from the text .SO file: a summary (.SUM) file and a binary Scenario File (.SF). The .SUM file is a text-based file containing a summarization of the scenario including track numbers and initialization information. The .SF file is used in Test Execution by the SG Server to run the scenario. The Pre-Test phase is depicted in Figure A.1-7.

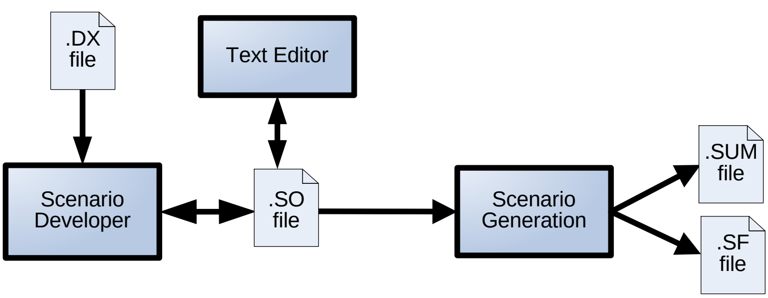

Figure A.1-7 SG Programs in the Pre-Test phase

☐ *Test Execution*

The Test Execution phase involves the SG Server, SG Workstation and SG Extractor with other components of the NRS to execute a test scenario as defined in the scenario file. The SG Server reads the binary scenario file (.SF), simulates the DLPs, and controls the execution of the test. The SG Workstation provides the user interface. The SG Extractor records messages passed between the various NRS components into a Data Extraction (.DX) file for post-test analysis, and supplies them to SG Workstation for display.

The Scenario Generator portion of the Test Execution phase is depicted in Figure A.1-8. Data is extracted and recorded from interfaces to other components, as well as interfaces between SG programs.

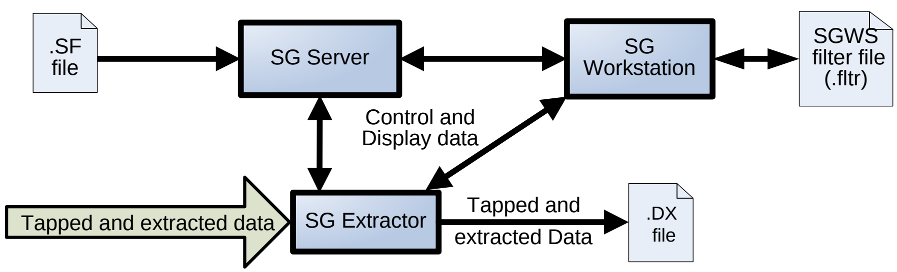

Figure A.1-8 SG Programs in the Test Execution phase

Test Execution can be performed with the different configurations, as detailed above in section A.1.2 NRS Configurations.

☐ *Post-Test*

Post-Test involves using the SG Data Reduction (DR) and/or SG Data Analysis (DA) programs on a Data Extraction (.DX) file from a previous Test Execution run.

Data Reduction uses a set of filters based on unit numbers, interfaces, networks and message types to produce an output file containing formatted messages. This output file is a simple text file with the extension of .DR.

Data Analysis is used to replay a Data Extraction file and to perform Expected Response comparisons to verify that expected events occurred within the applicable constraints. A summary list of expected response results is produced as a .TXT file. The Post Test phase is depicted in Figure A.1-9.

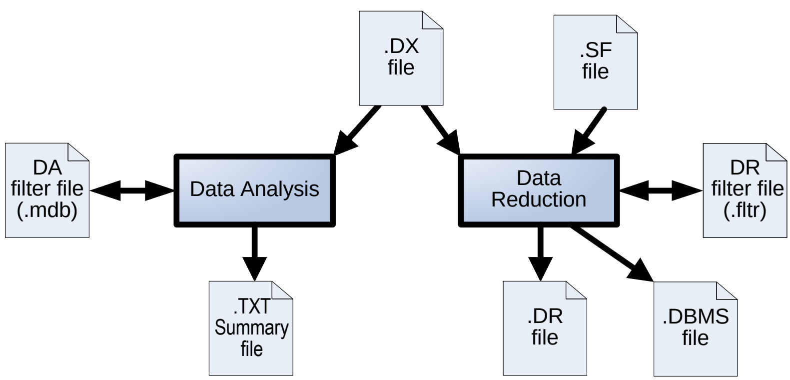

Figure A.1-9 SG Programs in the Post-Test phase

A.2 MLST3

The goal of the Multiple Link System Test & Training Tool (MLST3) is to provide a test tool that supports the development, life cycle support, and performance validation of the tactical data link systems employing Link 22, Link 16, JREAP and Link 11, as well as other communication interfaces. MLST3 provides capabilities to support the following test types.

- Conformance Tests
- Interoperability Tests
- System Integration Tests

MLST3 allows conformance and interoperability tests to be performed to verify the compliance of tactical data link systems implementation with the requirements set forth in the agreed standards and specifications. In addition, MLST3 provides facilities for developmental testing activity to achieve integration of tactical data link system components (for example, Host/Data Link Processor (DLP), System Network Controller (SNC), and communications equipment).

MLST3 was designed to re-use existing NRS components, to take advantage of the existing capabilities to the maximum extent possible, and to reduce development costs. The MLST3 standard hardware configuration for Link 22 is also suitable as an NRS. MLST3 and NRS/SNC software distribution and the authorization to use them are managed by different organizations.

This section covers the following topics.

- MLST3 Components
- MLST3 Configurations
- MLST3 Programs

A.2.1 MLST3 Components

The MLST3 provides multiple test configurations for different purposes, most of which require the approved use of SNC and NRS components, the distribution of which is managed by the NILE PMO. Similar to the NRS, MLST3 provides tools for scenario development, test execution, data recording and post-test analysis.

MLST3 provides active recording of the DLP-SNC Interface and the information exchanged between MLST3 and MS. It can also re-use the NRS SGEX, but does not provide the capability to verify expected responses. MLST3's post-test Automated Data Analysis Tool (ADAT) focuses on aspects of the Tactical Data Link message generation including recurrence rate. Scenarios generated for NRS are not interchangeable with MLST3, even though the differences are minor.

MLST3 can interface with a single SNC♦, providing DLP simulation for up to 32 simulated units. It can support up to five additional UUTs, for a total of 37 NILE units.

MLST3 can reuse the following NRS components previously described in the NRS section.

- SG Extractor program
- SNC and SNC Diamond
- LLC or LLC Simulator
- SPC/Radio or Media Simulator

A.2.2 MLST3 Configurations

The different MLST3 configurations are the following.

- Multiple Units
- Live Link
- System Simulation
- NCE Simulation
- Single

All of the above configurations require the approved use of SNC and NRS components, the distribution of which is managed by the NILE PMO.

MLST3 when used in standalone mode, mainly used as a training tool, does not require any other Link 22 HW or NRS SW.

Due to the serial connection speed requirements between LLCs and SPCs, or between LLCs and MS, LLCs and SPCs/MS are recommended to be co-located. When a SNC UUT is not co-located with MLST3, one of the following physical hardware schemes is typically used.

- LLCs and real SPCs/Radio co-located with SNC UUT
- SNC UUT LLCs and MS all co-located with MLST3
  - The SNC UUT- LLC connection must be provided by a secure transmission mechanism that meets timing requirements

☐ *Multiple Units*

In this configuration, up to five SNC UUTs can be run with up to 32 simulated units provided by the SNC♦. Each SNC UUT is connected to a Host/DLP. MLST3 simulates the DLPs for the SNC♦ units.

Figure A.2-1 shows an example of the Multiple Units configuration of the MLST3, with three SNC UUTs and their Host/DLP remotely located from the MLST3, with secure communication between SNC and LLC.

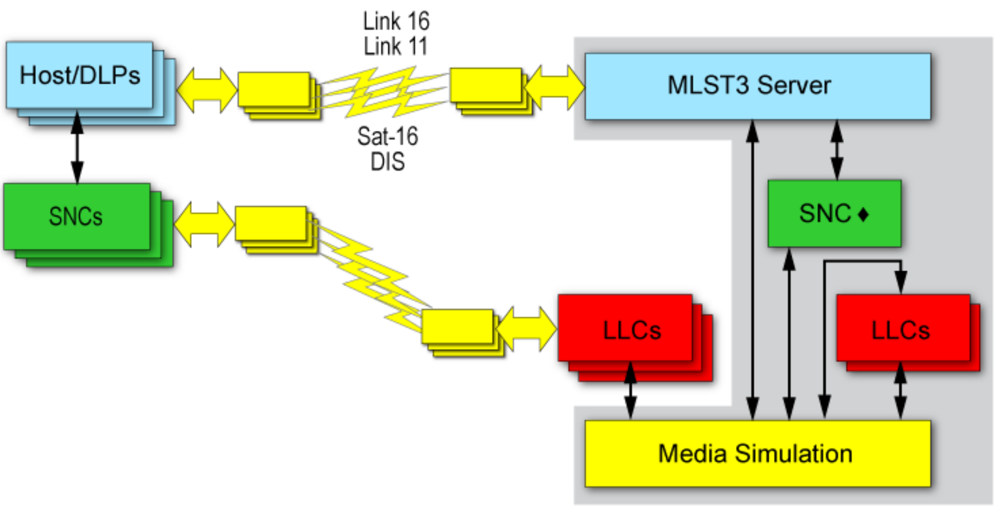

Figure A.2-1 MLST3 Single against MLST3 Server configuration

The main purpose of this configuration is to test national DLPs using a real SNC, with the MLST3 providing the remainder of the test environment. The DLP/SNC UUT may or may not be co-located with the MLST3. The DLP and SNC can be separated, but the feasibility of such a configuration is subject to security requirements and timing issues related to the physical network distribution.

☐ *Live Link*

The MLST3 Live Link configuration is similar to the Multiple Units configuration except that real SPCs are used to provide connectivity between the units on any Live Network. In this configuration the MLST3 can support both Live Networks using real SPCs, and simulated networks using MS. Real SPCs and MS SPC simulation cannot be combined on the same network. Only two units can be present per Live Network, one being simulated by the MLST3 and the other being a real DLP or a MSLT3 Single. Up to four Live Networks can be defined. MLST3 simulates the DLPs for the SNC♦ units. Physically, the Media Simulator associates a specific port of the LLC to a simulated unit defined in the scenario to be live on a network. Figure A.2-2 depicts the MLST3 in Live Link mode with one Live Network, in addition to simulated networks.

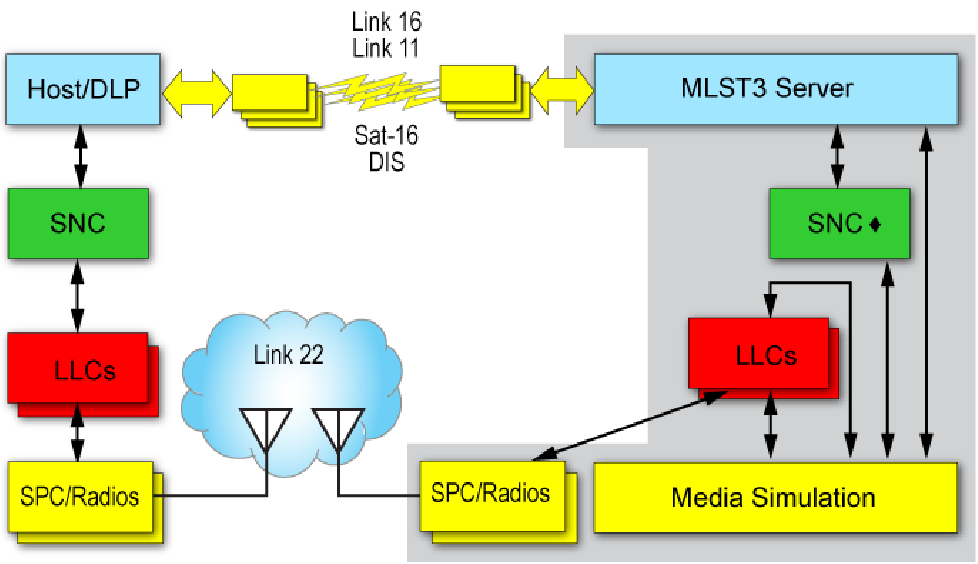

Figure A.2-2 MLST3 Live Link Configuration

☐ *System Simulation*

The System Simulation configuration is a lightweight simulation environment that requires just the SNC♦, Media Simulator and the MLST3 software to achieve a Link 22 simulation for up to 32 units. MLST3 simulates all of the DLPs. These three applications can all run on a single PC without any extra hardware (such as serial rocketports), making this configuration portable and rapidly deployable. Active MLST3 data recording can be used to verify tactical traffic and the DLP-SNC♦ interface. Figure A.2-3 shows the System Simulation configuration of the MLST3.

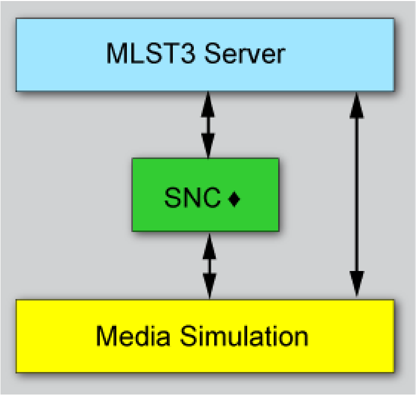

Figure A.2-3 MLST3 in System Simulation mode

☐ *NCE Simulation*

The NCE Simulation configuration is an extension of the System Simulation configuration. When using NCE Simulation, the MLST3 provides a proxy layer by assigning up to five Host/DLPs to their own unique simulated SNC♦ unit, through an SNC-to-SNC♦ adaptation layer. This proxy layer is transparent to the DLP because it connects to the MLST3 exactly the same way as it would an SNC UUT. This configuration supports the testing of a newer version of the DLP-SNC interface by using a newer version of the SNC♦, even when the interface version is not supported by MLST3. Additional simulated DLPs can be provided by MLST3, for a total combination of up to 32 units. This configuration shares the portability and lightweight advantages that the System Simulation provides. By enabling testers and integrators to “plug” a real DLP into a single-computer Link 22 simulated environment, the NCE Simulation configuration provides a rapid, lightweight DLP-SNC interface testing environment. Like the System Simulation configuration, NCE Simulation can be run entirely on one computer. Figure A.2-4 shows the NCE Simulation configuration of the MLST3.

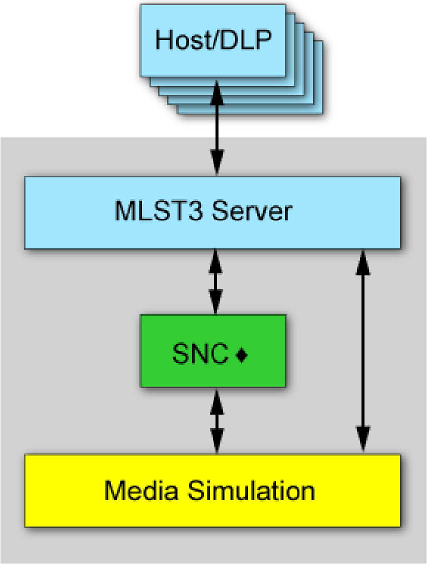

Figure A.2-4 MLST3 in NCE Simulation mode

☐ *Single*

MLST3 can also be used as a single unit DLP. In this manner, up to 125 separate instances of the MLST3 could be used, each controlling a unique SNC, to simulate up to 125 units. Real DLPs and MLST3 Single can be combined as in Figure A.2-5 to provide a Link 22 environment.

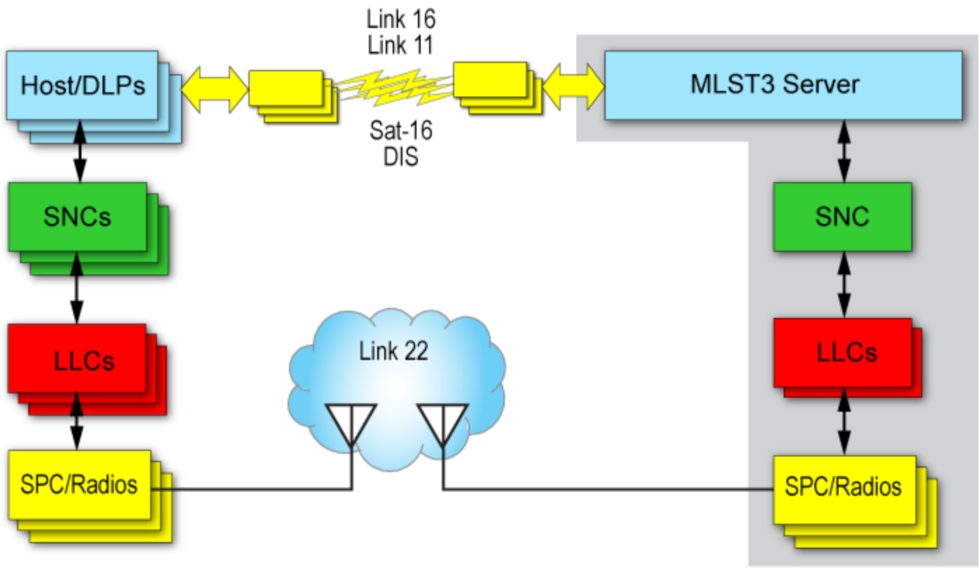

Figure A.2-5 MLST3 Single and Real DLPs

A.2.3 MLST3 Programs

Similar to the NRS, the MLST3 software includes several applications for use before, during, and after a test run, as detailed below.

- Pre-Test
  - Multi-Link Scenario Developer (MLSD)
  - File Conversion Utility
  - Product Configuration
  - Network Configuration
- Real-Time Test
  - Multiple Link Test System (MLTS)
  - DLSSEdit (Default text editor)
  - Documents (SUMs)
- Post-Test
  - Data Reduction (MLDR)
  - Automatic Data Analysis Tool (ADAT)

☐ *Pre-Test*

The Multi-Link Scenario Developer (MLSD) program is used to create (or update existing) scenario text files (.SO) and to generate scenario binary files (.SF) for execution, as shown in Figure A.2-6. Capabilities in MLSD are also available on-line during exercise conduct.

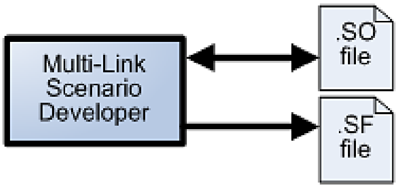

Figure A.2-6 MLST3 Pre-Test

The terminal load file conversion utility allows conversion of Link 16 terminal initialization data files into a number of different formats for use by the real time program.

The Product Configuration utility allows setup and customizing the configuration of all available links and options, including Distributed Interactive Simulation (DIS).

☐ *Real-Time Test*

The MLTS Real Time consists of two programs, the Data Link Server, and the Test Controller User Interface (TCUI), as shown in Figure A.2-7. The MLTS Data Link Server program provides for the following capabilities.

- Maintains track databases
- Performs Message Processing
- Provides data to TCUI for display
- Extraction of MLST3/DLP – SNC (or SNC♦) interface

The Test Controller User Interface program is responsible for the following.

- Provides the Human Machine Interface
- Displays the Tactical messages
- Provides the Tactical Situation Display

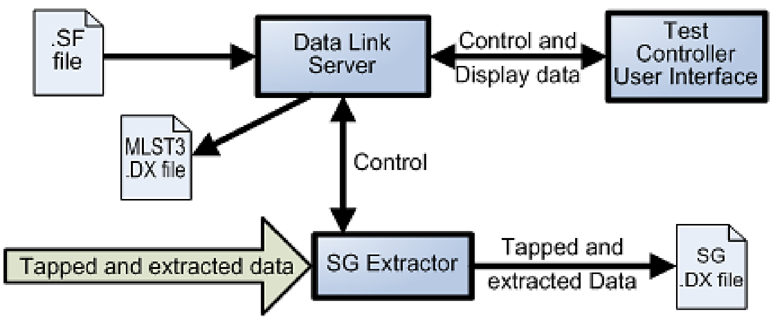

Figure A.2-7 MLST3 Real-Time

DLSSEdit is a text editor used to edit ASCII (scenario or configuration) files. MLST3 provides a convenient way of accessing an electronic version of the following Software User's Manuals (SUMs) through the help menu.

- Scenario Generator User's Manual (MLSG)
- Real Time User's Manual (MLTS)
- Post Test User's manual (MLDA)

☐ *Post-Test*

Post test programs are used upon completion of the Real Time program, and process data extraction files (.DX) that have been created during real time, as detailed below, and shown in Figure A.2-8.

Data Reduction converts binary data into a human-readable text formatted report. This report is output to a disk file or line printer. Data can be filtered in many ways selectable by the Operator.

ADAT analyzes messages for adherence to standard requirements. Input consists of data extraction files and output consists of an analyst data file (.ADF) and report file (.RPT).

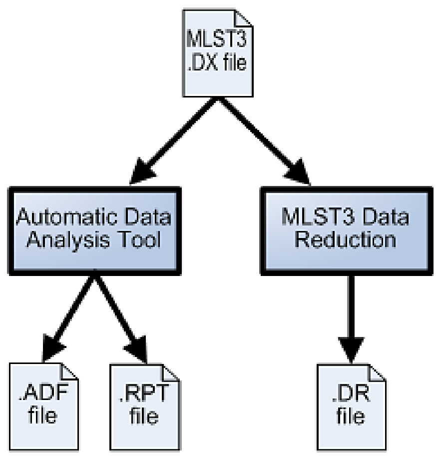

Figure A.2-8 MLST3 DX

Appendix B

Troubleshooting

This appendix provides useful information when establishing and troubleshooting Link 22, including the following topics of discussion.

- OLM Information Extraction
- Fault Management
- Error Rate Characteristics
- DLP
- SNC
- LLC/SPC
- Key Rollover
- TOD
- System Level Problems
- Frequently Asked Questions

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Appendix C
Minimum Implementation

This appendix provides the minimum implementation for a DLP in terms of the DLP to SNC Interface messages, and the minimum tactical data exchange requirements for Link 22, as defined in [STANAG 5522]. The following topics are addressed.

- DLP-SNC Minimum Implementation
- Minimum Tactical Data Exchange

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Appendix D
Initialization Parameter Generation

The DLP sends messages to the SNC during SNC Initialization, as discussed in Chapter 3 section 3B.1 SNC Initialization & Set-Up, and to initialize a network, as discussed in Chapter 3 section 3B.2 Network Initialization. This section identifies the parameters needed for these messages, and indicates where to find the data. This section is intended for software engineers that may be writing code to fill in the initialization messages, or for experienced operators that may need to manually enter fields for the messages if the software does not automatically do so.

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Appendix E
Acronyms and Abbreviations

AAW	Anti-Air Warfare
ACK	Acknowledgement
ACS	Automatic Comply Switch
AD	Access Delay
ADAT	Automated Data Analysis Tool
ADatP	Allied Data Publication
AJ	Active Join
ANSI	American National Standards Institute
APFS	Automatic Perform Function Switch
ASCII	American Standard Code for Information Interchange
AST	Air Specific Type
ASW	Anti-Submarine Warfare
ATH	Adjacent Timeslot Hand-Off
ATI	Altitude/Time Indicator
ATO	Air Task Order
BCC	Black Control CSCI
BIU	Black Interface Unit
BIT	Built-In-Test
BLOS	Beyond Line-Of-Sight
bps	Bits Per Second
C^2	Command and Control
C&S	Control and Status
CAM	Congestion Assessment Management
CANTCO	Cannot Comply
CAS	Course And Speed
CDH	CTIC/DS-101 Hybrid (encryption chip)
CIS	Configuration, Initialization & Status
CLRQ	Complementary Link Reception Quality
<CN>	Classified Number
CN	Capacity Need
CN/AD	Capacity Need / Access Delay
COMSEC	Communications Security
CONN	Connectivity Forcing/Erasing
COTS	Commercial off the Shelf
CQOL	Complementary Quality of Link
CRC	Cyclic Redundancy Check
Crypto	Cryptographic Unit
CSCI	Computer Software Configuration Item
CSM	Communication Service Message
CSR	Cancel Service Request
CT	Communications Transport
CV	Congestion Value

CVLL	Crypto Variable Logical Label
DA	Data Analysis
DCE	Data Communication Equipment
DECR	Decrypt
Dest	Destination
DFI	Data Field Identifier
DIF	DLP Interface
DIR	Directory Maintenance
DIS	Distributed Interactive Simulation
DIVS	Data Integrity Validation Service within the LLC
DLP	Data Link Processor
DLRP	Data Link Reference Point
DOW	Day of Week
DR	Data Reduction
DRX	DLP Interface Reception
DTD	Data Terminal Device
DTDMA	Dynamic Time Division Multiple Access
DTE	Data Termination Equipment
DTX	DLP Interface Transmission
DU	Data Unit
DUCC	Data Unit Configuration Code
DUI	Data Use Identifier
DUR	Data Update Request
DX	Data Extraction
E2ERN	End To End Reference Number
EDAC	Error Detection and Correction
EIP	Embedded INFOSEC Product
EMCON	Emission Control
ENCR	Encrypt
EPM	Electronic Protective Measures
ESI	Explicit Source Identification
EW	Electronic Warfare
FAM	Fault Management
FF	Fixed Frequency
FHS	Frequency Hop Set
FJU	Forwarding Link 16 MIDS Unit
FLOW	Flow Control/Metering protocol
FNU	Forwarding NILE Unit
FNUA	Forwarding NILE Unit to from TDL A (Link 11)
FNUAB	Forwarding NILE Unit to from TDL A and B
FNUB	Forwarding NILE Unit to from TDL B (Link 11B)
FPU	Forwarding Participating Unit
FRU	Forwarding Reporting Unit
GByte	Gigabyte
GD	Guaranteed Delivery
GDI	Global Data and Initialization
GHz	Gigahertz
Gnd	Ground
GPS	Global Positioning System
GRU	Gridlock Reference Unit
HF	High Frequency
HMI	Human Machine Interface
HR	High Reliability
HUR	High Update Rate
Hz	Hertz
ICV	Instantaneous Congestion Value
ID	Identifier
ID	Identity
ID	Identification
IDD	Interface Design Document
IEEE	Institute of Electrical and Electronics Engineers
IER	Interface Exchange Requirement
IJ	Inactive Join

ILM	Initialization, LNE and Configuration Management
IND	Indicator
INF	Infrastructure
INFOSEC	Information Security
INIT	Initialization
Intel	Intelligence
IP	Internet Protocol
IPROB	Initialization with Probing
ISO	International Organization for Standardization
ISS	In-Service Support
IU	Interface Unit
JCRYPDAT	Link 16 and Link 22 Cryptographic Data (OLM Set)
JREAP	Joint Range Extension Application Protocol
JTIDS	Joint Tactical Information Distribution System
JTRS	Joint Tactical Radio Systems
JU	Link 16 MIDS Unit
kHz	kiloHertz
KMP	Key Management Plan
LAD	Leg Acknowledged Delivery
LAN	Local Area Network
LANA	Lowest Allocatable NILE Address
LCD	Link Connectivity Data
LED	Light-Emitting Diode
Leg MPRN	Leg Message Packet Reference Number
LLC	Link Level COMSEC
LLS	Latitude/Longitude Scale
LNE	Late Network Entry
LO BATT	Low Battery
LOS	Line-Of-Sight
LRQ	Link Reception Quality
LSB	Least Significant Bit(s)
LVT	Low-Volume Terminal
MASN	Mission Area Sub Network
Mbps	Megabits per second
MCF	Media Coding Frame
MCM	Media Control and Management
MF	Management Function
MHz	Mega Hertz
MIDS	Multifunctional Information Distribution Systems
MIF	Media Interface
MIL-STD	Military Standard
MIN IMP	Minimum Implementation
MLDA	Multi-Link Data Analysis
MLDR	Multi-Link Data Reduction
MLSD	Multi-Link Scenario Developer
MLSG	Multi-Link Scenario Generator
MLST3	Multiple Link System Test & Training Tool
MLTS	Multiple Link Test System
MOD	Ministry of Defense
MODEM	Modulation and Demodulation
MOU	Memorandum of Understanding
MP	Message Packet
MP/NP	Message Packet to Network Packet ratio
MPA	Media Parameter Acquisition
MPE	Message Packet Expansion
MPR	Message Preparation Request
MPRN	Message Packet Reference Number
MPT	Message Preparation Time
MR	Machine Receipt
MRX	Media Reception
MS	Media Simulator

MSB	Most Significant Bit(s)
MSN	Media Setting Number
MTV	Message Time of Validity
MTX	Media Transmission
MUUT	Multiple Units Under Test
N/A	Not Applicable
NACK	Negative Acknowledgement
NATO	North Atlantic Treaty Organization
NCE	NILE Communications Equipment
NCH	NCS Handler
NCRYPLST	Network Cryptographic Resource Description (OLM Set)
NCS	Network Cycle Structure
NCSC	NCS Changes (due to DTDMA and LNE NCS)
NCT	Network Cycle Time
NILE	NATO Improved Link Eleven
NMASN	Link 22 (NILE) Mission Area Sub Network (OLM Set)
NMC	Network Management and Control
NMF	Network Management Function
NMM	Network and Monitoring Management
NMU	Network Management Unit
NN	NILE Network
NNCS	Link 22 (NILE) Network Cycle Structure (OLM Set)
NNET	Link 22 (NILE) Network Information (OLM Set)
NNETPART	Link 22 (NILE) Network Participants (OLM Set)
NNMEPARS	Link 22 (NILE) Network Media Parameters Settings (OLM Set)
NonC2	Non Command and Control
Non-MR	Non Machine Receipt
NP	Network Packet
NPG	Network Participation Group
NPP	Network Packet Production
NPR	Network Packet Reception
NRS	NILE Reference System
NSA	National Security Agency
NSNET	Link 22 (NILE) Super Network Information (OLM Set)
NST	Network Start Time
NU	NILE Unit
NUBWR	Link 22 (NILE) Unit Bandwidth Requirement (OLM Set)
NUDATA	Link 22 (NILE) Unit Data (OLM Set)
NULRQ	Link 22 (NILE) Unit Link Reception Quality (OLM Set)
OLM	OPTASK Link Message
ONCS	Operational Network Cycle Structure
OPORD	Operation Order
OPTASK	Operational Tasking
OST	Operational Start Time
OTC	Officer in Tactical Command
P2P	Point-To-Point
PC	Personal Computer
PI	Priority Injection
PII	Priority Injection Indicator
PLI	Participant Location and Identification
PMI	Packed Message Indicator
PMO	Project Management Office
PMW	Program Management Warfare
POS	Position
PPLI	Precise Participant Location and Identification
PPS	Pulses Per Second

PRNU	Potential Relay NILE Unit
PRQ	Probing Reception Quality
PRR	Preparation Request Response
PTOC	Partial Timeslot Ownership Change
PTT	Push-to-talk
PU	Participating Unit
QoS	Quality of Service
R/C	Receipt/Compliance
R2	Reporting Responsibility
RCC	Red Control CSCI
RCV	Routing Control Value
Ref	Reference
RF	Radio Frequency
RIU	Red Interface Unit
RPRNU	Reporting Potential Relay NILE Unit
RRM	Relay and Routing Management
RS	Reed-Solomon
RTA	Reallocation Total capacity Amount
RU	Reporting Unit
Rx	Receive
RxD	Receive Data
RxP	Reception Probability
SCH	Scheduler
SD	Scenario Developer
SDU	Secure Data Unit
Sec	Seconds
SER	Series
SG	Scenario Generator
SGEX	Scenario Generator Extractor
SGSV	Scenario Generator Server
SGWS	Scenario Generator Workstation
SHF	Super High Frequency
SIM	Simulation
SJ	Silent Join
SLURP	Slow Update Rate Protocol
SN	Super Network
SNC	System Network Controller
SNC♦	System Network Controller Diamond
SNMU	Super Network Management Unit
SPAWAR	Space and Naval Warfare Systems Command
SPC	Signal Processing Controller
SRID	Service Request Identifier
SS	Segment Specification
STANAG	Standardization Agreement
STD	Standard
SU	Supporting Unit
SUB	Subsurface
SUMs	Software User's Manuals
SUR	Standard Update Rate
SUR	Surface
SWAP	Swap Timeslots
TACT	Tactical Interface
TC	Totalcast
TCP	Transmission Control Protocol
TCUI	Test Controller User Interface
TDL	Tactical Data Link
TDMA	Time Division Multiple Access
TDS	Tactical Data System
TEG	Timing Event Generator
TFOM	Time Figure of Merit
TMW	Tactical Message Words
TN	Track Number
TOC	Timeslot Ownership Change
TOD	Time of Day

TOW	Time of Weekday
TQ	Track Quality
TRANSEC	Transmission Security
TRH	Transmission Request Handler
TSDF	Time Slot Duty Factor
TSN	Time Slot Number
TSR	Transmission Service Request
Tx	Transmission
TXC	Transmission Completed
TxD	Transmit Data
UDP	User Datagram Protocol
UHF	Ultra High Frequency
UK	United Kingdom
US	United States
UTC	Universal Time, Coordinated
UTL	Utilities
UUT	Unit Under Test
VME	Versa Module Europa
WGS	Worldwide Geodetic System
WILCO	Will Comply

Appendix F
Glossary

Access Delay	Describes the recurrence of transmission opportunities in the ONCS for a NU.
Access Delay Tolerance	Defines the tolerance that is considered acceptable in the calculated ONCS access delay.
Accuracy	A measure of the errors between what is perceived and what actually exists.
Acknowledge	The act of notifying a unit transmitting a message that the message has been correctly received.
Active Join	When a LNE unit wants to join a network and it is already an active member of at least one other NILE Network
ADAT	Automatic Data Analysis Tool
Address	A number applied to an Interface Unit to associate information and directives with Interface Units or tracks for both digital and voice communications.
Addressee	A unit to which a message is addressed
ASCII	American Standard Code for Information Interchange
Assignment Slot (AS)	A transmission timeslot, which is assigned for the use of a NU. Constructed of a contiguous number of Minislots.
Backward Compatibility	The ability of a DLP which is using an older definition of the DLP-SNC interface to use the latest version of the SNC software. When a technical message is expanded, the SNCs of older versions are able to interpret the portion of the technical message associated with its version or earlier versions, while new fields in a message will only be used by the newer SNCs.
Baud	A unit of modulation rate. One baud corresponds to a rate of one unit interval per second, where the modulation rate is expressed as the reciprocal of the duration in seconds of the shortest unit interval. 2. A unit of signaling speed equal to the number of discrete signal conditions, variations, or events per second.
BLACK Data	In cryptographic systems, data that has already been encrypted.
Broadcast (BC)	Generic term for the transmission of data to the Source's RF neighbors (i.e., no use of relay takes place).

C^2 platforms	Platforms that have the required equipment, mission and personnel to exercise command and control authority.
Cannot Comply (CANTCO)	A response message indicating that a function can not perform a previously requested function.
Capacity Need	Specifies how many tactical data words per second a NU wants to be able to transmit.
Communications Security (COMSEC)	The security measures that protect user data against unauthorized disclosure & tampering.
Compatibility	The ability of two communications systems to exchange data. NOTE Although Compatibility is necessary to achieve Interoperability, Compatibility does not guarantee Interoperability since Compatibility does not imply that the users of the communications systems are able to understand the data exchanged.
Complementary Link Reception Quality (CLRQ)	The measure of correct reception probability in the opposite direction to Link Reception Quality.
Control and Status Interface	A partition of the DLP/SNC interface, for the transfer of control and status information.
Data Element (DE)	A basic unit (class) of information having a unique meaning and subcategories (Data Items) of distinct units or values. The Link 22 Data Element is the DUI. In Link 22 (and Link 16) DUI is synonymous with Data Element.
Data Field Identifier (DFI)	A category of data whose specification includes one or more DUI specifications. Each DUI's class of data must fall within the bounds of the DFI category.
Data Forwarding	The process of receiving data on one digital data link and outputting the data, using proper format and link protocols, to another type of digital data link(s). In the process, a message(s) received on one link is translated to an appropriate message(s) on another link. Data Forwarding is accomplished by the selected forwarding unit(s) simultaneously participating on more than one type of data link. The data that is forwarded is based on the data received and not dependent upon the local system data of the data forwarding unit or its implementation of the received message or the forwarded message. Data Forwarding is not covered by the NILE system specifications.
Data Link	Means of communication for transmission and receipt of a data message.
Data Link Processing (DLP)	The set of functions, which allow a TDS to interface to the Link 22 SNC. These functions include the formatting and generation of Link 22 format messages, data filters, correlation, determination of Reporting Responsibility, etc. In a Data Forwarding unit, the forwarding of data between Link 22 and other tactical data links (Link 16, Link 11) is part of the DLP function.

Data Link Server	An MLTS program which is responsible for maintaining track databases, performing message processing, providing data to TCUI for display, and the extraction of MLST3/DLP-SNC (or SNC♦) interface.
Data Message	A group of binary digits (bits) containing encoded tactical information.
Data Originator	The IU which first injects data onto a tactical data link. During multi-link operations, the Data Originator need not be a NU.
Data Use Identifier (DUI)	In Link 22 (and Link 16), DUI is synonymous with Data Element.
Delay	The time between initiation of a process and completion of that process.
Destination	A NU or group of NUs to which a Message is addressed.
Direct LRQ	The LRQ value which represents how well the unit is able to receive directly from the other units in the network. This LRQ value is calculated using the Reception Probability (RxP).
DIS	Distributed interactive Simulation
Duplicate Detection	Duplicate Detection is the process used to determine whether a Message Packet (MP) has already been received or not. In order for a MP to be a duplicate the following attributes all have to be the same: Message Time of Validity (MTV), Source (MILE Address), Type (Tactical or Technical), and Data Unit (Size and Contents).
Dynamic List Address	A means of addressing a message to a limited number of NUs. (Differs from MASN in that the members of the dynamic list are not predefined.)
Dynamic TDMA (DTDMA)	A form of TDMA where ownership of transmission capacity is transferred between NUs. (Note the length of the NCT remains unchanged by the DTDMA processes.)
Efficiency	The degree to which a system provides quality of service measured in terms of throughput, delay and reliability.
Electronic Counter Counter Measures (ECCM)	The division of EW involving actions taken to ensure friendly effective use of the electromagnetic spectrum despite the enemy's use of EW. (Used interchangeably with Electronic Protective Measures (EPM)).
Electronic Protective Measures (EPM)	The division of EW involving actions taken to ensure friendly effective use of the electromagnetic spectrum despite the enemy's use of EW. (Used interchangeably with Electronic Counter Counter Measures (ECCM)).
Electronic Warfare (EW)	Military action involving the use of electromagnetic energy to determine, exploit, reduce, or prevent hostile use of the electromagnetic spectrum and action taken to retain its effective use by friendly forces.
Error Detection and Correction (EDAC)	A technique or scheme for coding information such that transmission errors can be detected and corrected.
FJ-Series Message	J-Series messages packed into a 72-bit word for use on Link 22.
FJ Unit	A unit communicating on Link 22 and Link 16 while forwarding information among Link 22 and Link 16 participants

Flexibility	The ability of a system to react positively to change.
Flooding	The relay of designated data by each NU receiving that data. Flooding is used to provide a high probability of reception of specified data by all NUs in a NILE network.
Forwarding NILE Unit (FNU)	A NILE Unit that has the responsibility for the transfer of data between Link 22 and one or more other data link(s). To achieve this, the FNU must be capable of concurrent operation on Link 22 and the other data link(s). This term and functionality are no longer used.
Fragment	An incomplete part of a message.
Frequency Hopping (FH)	An EPM technique in which the instantaneous carrier frequency of a signal is periodically relocated, according to a predetermined code, to other positions within a frequency band much wider than that required for normal message transmission. The receiver uses the same code to keep in synch with the hopping pattern.
F-Series Message	Digital message format employed in STANAG 5522.
Guaranteed Delivery (GD)	A NCE protocol whereby a message is automatically retransmitted until the destination confirms correct reception or the system determines that the destination is unreachable at an acceptable cost.
Guard Time (GT)	A time interval left vacant between transmissions, used for the switching and/or tuning of radios and used to account for propagation delay.
Header	Information to support the communications services required by an associated block of information (as opposed to the information itself).
High Reliability (HR)	A transmission service that provides a higher statistical probability of correct reception.
Hop	The dwell time of a frequency hopping system.
Host System	Also known as he Tactical Data System (TDS), which processes the received tactical messages and generates tactical messages for transmission in accordance with the unit's national requirements.
Inactive Join	When the LNE unit requests to join a network and it is not an active member of any NILE Networks.
Inactive NU Status	Any NU currently not part of the (Super) Network (Failure, Maintenance, etc.) with or without a Timeslot assigned.
Information Security (INFOSEC)	The protection of information against unauthorized disclosure, transfer, modification, or destruction, whether accidental or intentional. INFOSEC includes COMSEC, NETSEC, and TRANSEC.
INFOSEC Subsystem	The set of functions, which provides the required level of INFOSEC for the Link 22 system.
Integrity	A characteristic of INFOSEC in which unauthorized modification, creation or deletion of information objects can be detected. Also referred to as LLC Integrity.
Interface Unit (IU)	A NU, JU, PU, or RU communicating (directly or indirectly) on the Data Link interface.

Interoperability	The ability of systems, units, or forces to provide services from other systems, units, or forces and to use these services so exchanged to enable them to operate effectively together.
J-Series Message	Digital message format employed in STANAG 5516.
Key Rollover	This rollover causes the Day Of Week (DOW) of the LLC (when 1 to 6) to increase by one, and if the DOW is at 7 this causes the DOW to be reset to 1 and the LLC to rollover the key to the next week's key.
Key Zeroization	Deletion of the key held by the LLC.
Late Network Entry (LNE)	The procedure required permitting a non-participant in an established NILE Network to become a member of the network.
Leg	The communications link between a pair of NUs that are RF neighbors on one or more Networks. Also a unit of measure of the length of a communications path between NUs – the length, in legs, of the communications path between NUs is defined as: 1 + number of Relay NUs in the Path.
Leg Injection Packet (LIP)	A distinct block of information used to communicate a set of Messages and or Message Fragments requiring the same communications services. A LIIP is subdivided into a Data Unit (DU) and a Service Header (SH) where the DU contains the Message(s) or fragment of a Message and the SH contains the protocol information required to communicate the message.
Leg Reliability	The protocol used by the SNC to determine the number of transmissions required and the number of fragments allowed, to meet the requested reception reliability. This protocol is performed independently for each required leg.
Link 11	An automatic high speed HF/UHF data link exchanging picture compilation, command status, and control information. It uses M Series messages, a Roll Call protocol and kineplex waveform. Also referred to as TADIL A.
Link 16	A secure jam resistant nodeless data link that utilizes the Multifunctional Information Distribution System (MIDS) and the protocols, conventions, and fixed word message formats defined by STANAG 5516. Also referred to as TADIL J.
Link 22	A secure tactical data link which uses the NCE and the protocols, conventions and message formats defined by STANAG 5522.
Link 22 Address	A 15-bit number used by the TDS/DLP segments of the Link 22 system to uniquely identify each NU. The Link 22 Addresses are coordinated with those of other data links (e.g. Link 16) and are distributed to NUs via the OPTASK LINK message prior to the deployment of an SN. Link 22 tactical messages and DLP/SNC interface messages use the Link 22 Address to identify NUs. A NU must have been allocated a Link 22 Address before it can participate on Link 22.
Link Connectivity Data (LCD)	Represents the SN bi-directional connectivity between two NUs that are three legs away.

Link Level COMSEC (LLC)	A COMSEC function provided within the Link 22 Media segment. It provides both COMSEC and NETSEC for Link 22.
Link Quality (LQ)	The bi-directional measure of correct reception probability on a given RF link.
Link Reception Quality (LRQ)	The measure of correct reception probability on a given (unidirectional) RF link.
Live Link	An MLST3 test configuration similar to the Multiple Units configuration except that real SPCs are used to provide connectivity between the units on any Live Network.
Machine Receipt (MR)	A destination which requires an acknowledgement from the addressees. MR destinations may take precedence over Non-MR destinations. An end to end acknowledgement.
Major Version Number	One part of the SNC Version. The Major Version Number changes only when there is an incompatibility between major SNC versions.
Maximum Perishability	The maximum lifetime for a message.
Media	In the NCE system architecture, the Media segment provides the Data Link and Physical (Layer 1 & 2) functions. Its primary function is to provide a NP delivery service on each frequency band for which a NILE capability is required. The Link 22 Media segment includes the Link Level COMSEC, SPC and Radio subsystems.
Media Coding Frame (MCF)	The smallest unit of data, which is exchanged in peer to peer communications between NUs at the Data Link Layer.
Media Dependent	Having a different value when used with different NILE media.
Media Setting Number	Specifies the setting of SPC parameters: Waveform, Modulation, Guard Time, Repetition Rate, and EDAC parameters. It consists of a reference for the SPC to the appropriate set.
Message	The collection of information, which needs to be communicated to achieve a prescribed objective. A Link 22 Message consists of a number of fields in a fixed arrangement.
Message Packet	An entity used by the SNC to contain message data that is to be sent to a common set of addressees with a common service requirement.
Message Packet Store	The storage used by duplicate detection to save information about the message packets that have been received and their contents, so that it may detect whether a received message packet is a duplicate.
Message Preparation Request (MPR)	A message on the DLP/SNC control & status interface used by the SNC to request tactical message data from the DLP.
Message Preparation Time (MPT)	The time required by the DLP to produce tactical messages in response to a MPR.
Message Source	The NU from whom a message was received, i.e. the RF neighbor NU whose transmission has been received.
Message Time of Validity (MTV)	The TOV of an individual message.

Minislot	The smallest unit of time into which the NCS is allowed to be subdivided. A NCS consists of an integer number of Minislots. The size of a Minislot is media dependent.
Minor Version Number	One part of the SNC Version. The Minor Version number is used for all SNC changes which are backward compatible with previous Minor Versions for the same Major Version.
Mission Area Sub Network (MASN)	A group of one or more NUs sharing a common collective address.
MLSD	Multi-Link Scenario Developer
MLST3 Single	An MLST3 test configuration in which MLST3 is used as a single unit DLP.
MS Standalone	An NRS configuration which allows the testing of a national DLP without using real SPCs, which are replaced by the Media Simulator.
M-Series Message	Digital message format employed in STANAG 5511 Edition 2 (Edition 3 is in the process of ratification. After ratification, it will supersede Edition 2).
Multi-Link System Test & Training Tool (MLST3)	The interoperability test system which was extended to incorporate Link 22, and has multiple configurations available for testing.
Multiple Units	An MLST3 test configuration which can be run with up to five SNC UUTs with up to 32 simulated units, provided by the SNC♦. The main purpose of this configuration is to test national DLPs using a real SNC, with the MLST3 providing the rest of the test environment.
Multiple Units Under Test (MUUT)	An NRS configuration which provides the ability to test between two and five real SNCs (UUTs), without the use of simulated units. This configuration also tests the functionality of the LLC.
NCE Simulation	An MLST3 test configuration which is an extension of the System Simulation configuration.
Neighborcast (NC)	Delivery of messages to all RF neighbors.
Net	Synonymous with Network.
Network	See NILE Network.
Network Connectivity	The topological description of a network, which specifies the interconnection of the transmission nodes in terms of circuit termination locations and quantities.
Network Cycle	A periodic, recurring sequence of Timeslots during which each active NU has at least one Assignment Slot.
Network Cycle Structure (NCS)	The partitioning and allocation of transmission capacity/opportunities within a Network Cycle.
Network Cycle Time (NCT)	The time taken to complete a Network Cycle.
Network Initialization (NI)	The processes required enabling a Network to become operational.

Network Management Unit (NMU)	The NU responsible for the management of a NILE Network during normal operations.
Network Packet (NP)	SNCs communicate information on NILE Networks using Network Packets. A NP consists of an integer number of LIPs together with a Network Packet Header. A NP is either received complete and correct or not received at all. The size of a NP is media dependent.
Network Packet Header	Information inserted into a NP to enable the LIPs contained in the NP to be packed efficiently in the NP and to be unpacked by receiving NUs. The NP Header size and contents are dependent on the capacity of the NP for which it is generated.
NILE	1. NATO Improved Link 11 (NILE) is the former name for Link 22, and as such is used in some earlier documentation and is synonymous with Link 22. 2. NILE is also used to refer to the international project organization to support the development of the NCE. See also NILE Communications Equipment.
NILE Address	A 7-bit number used by the SNC segment of the Link 22 system to uniquely identify each NU in a SN. NILE Addresses are automatically allocated to NUs during SN initialization. The SNMU will be responsible for managing the allocation of NILE Addresses to NUs that did not obtain a NILE Address during SN initialization. The SNMU may also allocate NILE Addresses to RUs to enable them to be identified as the source of data forwarded from other data links. The NILE Address is not visible to the TDS/DLP segments of the Link 22 system.
NILE Communications Equipment (NCE)	A communications system to support Link 22. NCE consists of a DLP interface, a System Network Controller (SNC), a Link Level COMSEC subsystem, and the appropriate Signal Processing Controller(s) / radio equipment.
NILE Network (NN)	A collection of NUs exchanging information in accordance with STANAG 5522 using a single medium and a unique set of network parameters.
NILE Reference System (NRS)	Test tool essential to the development, life cycle support, and performance validation of the Link 22 system. The NRS will verify the Link 22 system compliance with requirements established in the Link 22 System specification, the System Network Controller specification and other specifications associated with NILE development.
NILE Super Network (SN)	A deployed Link 22 system that may operate using one or more connected NILE Networks.
NILE Unit (NU)	A NILE node with a Link 22 address. It is capable of transmitting and/or receiving information in accordance with STANAG 5522.
Non- C^2 platforms	Platforms executing or supporting missions that receive information and may also contribute information to the picture.
Non Machine receipt Addressee (Non-MR Addressee)	An Addressee who is not required to respond with a Machine Receipt.

OSI Seven Layer Model
A communications architecture model proposed by the internal Standards Organization, comprising the following layers:

1. Physical Layer
2. Data Link Layer
3. Network Layer
4. Transport Layer
5. Session Layer
6. Presentational Layer
7. Application Layer

Overhead
Digital information transferred across the functional interface separating a user and a telecommunications system (or between functional entities within a telecommunications system) for the purpose of directing or controlling the transfer of user information and/or the detection and correction of errors.

NOTE: Overhead information originated by the user is not considered as system overhead. Overhead information generated within the system and not delivered to the user is considered as system overhead. Thus, user throughput is reduced by both overheads while system throughput is only reduced by system overhead.

Participating Unit (PU)
A unit with a Link 11 address.

Perishable Message
A message, which is identified as having a finite lifetime.

Point-to-Point
A transmission mode that provides delivery of the associated message to a specific NU. (This does not mean that other NUs cannot receive and/or understand the message.)

Potential Relay NILE Unit (PRNU)
A NU that is capable of performing Relay in the current NILE Super Network configuration.

Preamble
Information about a call and its contents provided at the start of a digitized message. In addition, a name sometimes given to the initial training sequence of a Single Tone (HF) Modem.

Preparation Request Response (PRR)`
A message on dhte DLP/SNC control and status interface used by the DLP to identify tactical messages being supplied in response to a MPR.

Priority
An attribute of a Message used by the SNC to schedule transmissions. Messages have a priority in the range 1-4, with 1 being the highest.

Priority Injection Indicator (PII)
The Priority Injection Indicator is a flag which can be set in only TSR's for a tactical message with Priority 1. The PII when set indicates that it is an important message which is eligible for early transmission in a Priority Injection slot. When the PII is set, the TSR is put at the bottom of any other PII TSRs which are at the top of the TSR Queue for Priority 1.

Priority Injection Slot (PI Slot)
A Timeslot not assigned to any NILE Address (has a NILE Address of zero). Only used for the transmission of Priority 1 Tactical messages that are eligible for additional early transmission. Used for an additional earlier transmission of important messages when the next assigned timeslot is more than 2.5 seconds later.

Priority Message
A message, which is eligible for transmission in an Interrupt Slot.

Probing	A mechanism to assess the quality of the radio channel in order to get the knowledge of the Network connectivity (used during Network Initialization).
Protocol	A set of unique rules specifying a sequence of actions necessary to perform a communications function. NOTE: Protocols may govern portions of a network, types of service, or administrative procedures. For example, a data link protocol is the specification of methods whereby data communication over a data link is performed in terms of the particular transmission mode, control procedures, and recovery procedures.
Quality of Service	A set of qualities related to the provision of a service, as perceived by a user.
Radio Silence Status	Any NU that has a Timeslot assigned, but by choice or order is not allowed to transmit. It is able to receive, but not send and acknowledge messages. It may break the 'Radio Silence' status and inject messages upon request of its own DLP.
Real Time	Real Time is when the delay introduced by a system is critical to the users of that system or an associated system.
Reallocation	The transfer of transmission capacity from one NU to another after it has been determined that the required conditions for making the Reallocation are met according to information held by the Donor NU.
Receive Only NU Status	Any NU that has NO Time Slot assigned and is only receiving messages on all networks.
RED Data	In cryptographic systems, data that has not been encrypted.
Relay	The retransmission of data received from another NU. Relay is intended to increase the range coverage of Link 22 and to increase the probability of correct reception by the intended recipient(s). Relay may take the form of retransmission on the same or different NILE network from the one on which they were received.
Relay Setting – Automatic	(R)PRNU status depends on the de-centralized Relay Status-determination protocol.
Relay Setting - Inhibited	NU is inhibited by the SNMU from acting as a RNU or a (R)PRNU.
Relay Setting - Preferred	NU is assigned by the SNMU as a preferred RPRNU.
Relay Unit	A NU, which is performing Relay.
Reporting Potential Relay NILE Unit (RPRNU)	RPRNUs are a special subset of PRNUs that are used to minimize injections when MPs are required to be routed to undetermined destinations and/or multicast addresses.
Reporting Responsibility	The requirement for the IU with the best positional data on a track to transmit track data on the interface.
Reporting Unit	A RU is the unit taking part in the exchange or transfer of tactical data on another digital data link (not Link 22) to which data can be addressed, and from which data can be identified as to source.

Resilience	The ability to recover quickly from undesired change.
Role Loss Timeout	The number of minutes that the SNC should wait before declaring the loss of the (S)NMU.
Roll Call	Normal mode for current Link 11 operation. Unit polled by the net control station broadcasts its data, then relinquishes the network to the net control station, which then polls another unit in accordance with a predefined polling sequence.
Routing	The intelligent determination of the path to be followed by messages, from the Originator to the final Destination.
Scenario Generator (SG)	A collection of tools for scenario development, test execution, data recording, and data analysis that are used to prepare, execute, and analyze tests with the NRS.
Sequence Identifier	An ID which is used to bind requests with responses. The request, subsequent request messages, and the associated response message will all have the same Sequence Identifier. Messages with the same Sequence Identifier are collectively called a transaction. The Sequence Identifier is managed by the SNC and are monotonically increased in successive transactions.
Service Header	Part of a LIP containing the SNC protocol information that is required by the receiving NUs to process the accompanying Data Unit. The protocol information contained is dependent on the communication service options selected for communication of the message, e.g. High Reliability, Machine Receipt.
Service Request	A request for service from a client application to a service application.
Service Request Identifier (SRID)	An identifier used by the DLP/SNC interface to identify Transmission Service Requests (TSRs).
Signal Processing Controller (SPC)	The NCE segment which roughly corresponds to the Data Link and Physical Layers in the ISO 7 Layer Communications Model. The functions of the SPC include Error Detection and Correction, Signal Modulation/Demodulation and TRANSEC.
Silent Join	When the LNE unit is not an active member of any NILE Network and wants to listen to the network without making any transmissions
Slot	Timeslot
SNC Diamond (SNC♦)	A component of the NRS. The SNC♦ is capable of representing either a single SNC or a community of SNCs.
SNC Verification	The primary NRS configuration used to verify the functionality of the SNC. SNC Verification involves a single SNC UUT being tested with up to 124 simulated units. The media connectivity is provided by the Media Simulator.
Source	The NU from which a transmission is received.
Super Network (SN)	NILE Super Network

Super Network Directory	Information about Units in the Super Network including: a) Link 22 and NILE Addresses b) Mission Area Sub Network c) NU Status and Relay Setting of each NU d) Roles.
Super Network Management Unit (SNMU)	The NU responsible for the management of a NILE Super Network during normal operations.
Synchronization	The process of adjusting corresponding significant instants of two signals to obtain a desired fixed relationship between these instants.
System Network Controller (SNC)	The NCE segment that roughly corresponds to the Transport & Network Layers in the ISO 7 Layer Communications Model. The primary function of the SNC is to provide a basic end to end message communications service between NUs which are members of a deployed NILE Super Network.
System Simulation	An NRS configuration which is used to validate NRS test scenarios. This configuration uses multiple computers to ensure that sufficient computer resources are available, especially when running stress test scenarios.
Tactical Data System	The source and sink for Link 22 tactical messages. In Link 22, TDS is used as a generic term for a command and control system that uses Link 22.
Tactical Interface	The partition of the DLP/SNC interface used for passing tactical messages.
Tactical Message	A functionally oriented, variable length, string of one or more words in fixed word format.
Takeover	The ability of the Standby (S)NMU to assume the role of (S)NMU, if a loss is detected.
TDL Management	TDL Management is the function performed by the unit responsible for initiation, operation, and termination of data link operations. This unit may delegate management of portions of the architecture, including portions of the link 16 network, to subordinate units.
Technical Message	A functionally oriented, variable length group of related fields containing information for the maintenance and optimization of the network (Network Management)
Test Controller User Interface (TCUI)	An MLTS program which is responsible for providing the Human Machine Interface (HMI), displaying the tactical messages, and providing the tactical situation display.
Time Division Multiple Access (TDMA)	A communication technique that utilizes a common channel (multipoint or broadcast) for communications among multiple users by allocating unique timeslots to the different users.
Time Figure of Merit (TFOM)	Defines the inaccuracy of the Time of Day in regards to the Universal Time.

Time Index	The index into the MP and E2ERN data structures. The Time index is calculated using the modulus function and the Message Time of Validity, taking into account any midnight boundaries that have been crossed and the length of the circular buffer.
Time of Validity (TOV)	The reference time at which data is considered to be valid. The SNC uses the time of occurrence of a Timeslot to determine this reference time; either the Timeslot in which the message is received or an offset from that Timeslot as indicated in the Service Header.
Timeslot	A period of time during which messages may be transmitted or received. An integer number of Minislots.
Totalcast (TC)	The transmission mode where the Destination is all the NUs in the NILE Super Network.
Track	A collated set of data associated with a track number for the purpose of representing the position and/or characteristics of a specific object, point or bearing.
Track Number Block	A defined range of consecutive track numbers assigned to an IU.
Track Quality (TQ)	A scale of numbers, which indicates a system's estimate of the accuracy of the reported position of a track.
Transmission Security (TRANSEC)	The component of INFOSEC that results from all measures designed to protect transmissions from interception, jamming, transmission detection, and traffic flow analysis.
Transmission Service Request (TSR)	A message on the DLP/SNC control & status interface used by the DLP to indicate a requirement to transmit a tactical message.
Update Rate	The frequency at which a specified category of message is to be retransmitted.

Appendix G
References

The documents referenced within this guidebook relate to the layered architecture of Link 22 as shown in Figure G-1.

DLP	ADatP-33 EXTAC 779 STANAG 5522 STANAG 5616 Volume II STANAG 5616 Volume III
DLP-to-SNC Interface	DLP-SNC IDD
SNC	SNC SS SNC SDD
SNC-to-LLC Interface	LLC IRS
LLC	LLC OPM LLC KMP
LLC-to-SPC Interface	LLC IRS
SPC	SPC SS
Radio	STANAG 4205 STANAG 4285 STANAG 4372 STANAG 4444 STANAG 4539
TOD	STANAG 4430 NRS IDD

Figure G-1 Layered Architecture to Document Reference Mapping

The documents referenced within this guidebook are listed below, along with the version/edition of the document that was current at the time this version of the guidebook was produced.

ADatP-33	Multi-Link Standard Operating Procedures for Tactical Data Systems employing Link 11, Link 11B, Link 16, IJMS and Link 22 March 2008
DLP-SNC IDD	Interface Design Description for the Data Link Processing Segment and the System Network Controller for the NATO Improved Link Eleven (NILE) Program NG 278-A013-DLPIDD/B4
EXTAC 779	OPTASK LINK Message and SNC Initialization Data For LINK 22 - Working Paper for the NATO Improved Link Eleven Version 2.2.1
LLC IRS	Interface Requirement Specification (IRS) for the Link-Level COMSEC (LLC) Segment of the Link 22 (NILE) System NG 278-A018-LLCIRS/B4
LLC KMP	NATO Improved Link Eleven (NILE) Link Level COMSEC Device (KIV-21/LLC) Key Management Plan (KMP) Version 3.0 VSD-608593-02-126-02, Rev 3.0
LLC OPM	Link Level COMSEC Operator's Manual, Spares List, and System Integrator's Guide VSD-608518-98-355-02, Rev. B
NRS IDD	Interface Design Description for the NILE Reference System for the NATO Improved Link Eleven (NILE) Program NG 278-A018-NRSIDD/B4
NRS STM	System Technical Manual for the NILE Reference System (NRS) and interfaced System Network Controller (SNC) NG 278-A018-NRSSTM/B4
SNC SDD	SNC Software Design Description for the NATO Improved Link Eleven (NILE) Program NG 278-A013-SNCSDD/B4.
SNC SS	Segment Specification for the System Network Controller (SNC) of the Link 22 (NILE) System NG-278-A013-SNCSS/B4
SPC SS	Segment Specification for the Signal Processing Controller (SPC) of the Link 22 (NILE) System NG 278-A018-SPCSS/B4
STANAG 4205	Technical standards for single channel UHF radio equipment Edition 3
STANAG 4285	Characteristics of 1200/2400/3600 bits per second single tone modulators / demodulators for HF radio links Edition 1

STANAG 4372	SATURN – A fast frequency hopping ECCM mode for UHF radio Edition 3
STANAG 4430	Precise Time and Frequency Interface and its Management for Military Electronic Systems Edition 1 Draft
STANAG 4444	Technical Standards for a Slow-Hop HF EPM Communications System Edition 2
STANAG 4539	Technical Standards for Non-Hopping HF Communications Waveforms Edition 1
STANAG 5522	Tactical Data Link – Link 22 Edition 4
STANAG 5616 Volume II	Standards For Data Forwarding Between Tactical Data Systems Employing Link 22 and Tactical Data Systems Employing Link 16 Edition 5
STANAG 5616 Volume III	Standards For Data Forwarding Between Tactical Data Systems Employing Link 22 and Tactical Data Systems Employing Link 11/11B Edition 5

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